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State Scholarships and Others.

THERE will probably be general agreement that our educational system is seriously at fault at the present moment, if, while spending many more millions than it did before the War, it fails to provide, for the sons of the middle class and the poor, opportunities at least as good as were available ten years ago. For it is certain that less now than ever before can we afford to let ability, from whatever social class it comes, run to waste, or be thwarted of its natural career. In the difficult times which Great Britain has to face, the demand for first-rate brains fully trained for the service of the State and the professions, industry and commerce, is almost unlimited. It is not difficult to show that, in this important field of educational provision, things are distinctly worse than they were. The subject was brought before the Headmasters' Conference by Dr. Cyril Norwood during the recent annual meeting held at Winchester College, and a resolution was carried unanimously directing the attention of the Board of Education and Local Education Authorities to the present difficulties and anomalies in connexion with the passage of promising pupils from secondary schools to universities.

The explanation of the position is simple ; it is just that the financial conditions have changed, and have not yet been readjusted. It was the natural ambition of a clever boy in old days to win an open scholarship at Oxford or Cambridge, and if he could do so, the way was generally open for him to go into residence, since a school-leaving exhibition and some moderate help from the Local Education Authority made him reasonably well-to-do. But now, owing to the changes which the War has produced, to reside at one of the older universities for half the year costs about 230*l.* Towards this a poor boy can obtain 80*l.* from an open scholarship, perhaps 50*l.* as a leaving exhibition from his school, perhaps 50*l.* from his County Council or Local Education Authority, and that leaves a balance of 50*l.* to come from the pockets of parents, or from some outside source, besides the cost of maintenance for the other half of each year.

As a result of this position, there is taking place in the schools a considerable leakage, first, of boys who, having the ability, do not even try to carry out the course which leads to an open scholarship at Oxford or Cambridge, and, because they cannot see their way through to the end, do not start upon it at all ; and secondly, there is a further loss of those who, hoping for something to turn up, do the work, and attain the standard, but at the last moment find themselves compelled to abandon the project.

In order to ascertain the facts, letters of inquiry were

addressed quite recently to a number of headmasters in different parts of the country, and in very different types of schools, which were alike only in this, that they had been in the habit of sending a succession of able poor scholars to the universities. The answers all alike bore witness to the reality of the grievance. One, the headmaster of a school in a small country town, quoted the case of his sixth form of six boys, where one, the bottom boy, being the son of parents who had saved 200*l.*, and were willing to spend it in his education, went up to Cambridge with an 80*l.* scholarship which he won; but the other five, who were all above him, and better scholars, were not able even to become competitors. In this one school, therefore, in the year just past, five suitable students were lost from the universities. Another, the headmaster of a large town grammar school, wrote to say that in the last twelve months he had lost from his school at least six boys who in happier times would have gone forward to open scholarships in various subjects.

The headmaster of a great school in a great city, said that in his opinion the position was becoming worse, that only his very best boys could just manage a course at Oxford or Cambridge, and that many candidates were dropping off. Another, the head of a great school in the north, famous for the scholarships which it has won in the past, wrote that this year they would have the worst year they had known for thirty years past, and for no other reason than that of financial stringency. The school had the boys, and the boys had attained the standard; but they could not go forward. It is unnecessary to quote all the evidence; it is the same tale from them all. To confirm it, it is only necessary to ask the opinion of any headmaster of any suitable school outside London; he will bear witness to the reality of the present hardship.

Of course, there are some districts in which the way is made somewhat easier than in others, and the remarks which are here made do not apply at all to the area which is administered by the London County Council. Outside that happy region, there are some Local Education Authorities which do much to assist the poorer, just as there are some colleges which do a good deal to help; but there are many which either cannot or will not do much. On the whole, it has been the unfortunate truth that just at the time when necessary expenses have mounted, and when parents have become poorer, the local authorities, quite naturally from their point of view, have been reducing or withdrawing their assistance; even in some cases they have made it a rule to refuse all assistance save to applicants who could show that they had sufficient resources to go into residence apart from any such help as might be given them. In any case, it is surely bad national economy, and from a democratic point of view a monstrous iniquity, that a first-class boy in a rural or poor county should be denied an education which is well within the range of a comparatively second-rate boy who dwells within the ambit of the London County Council.

This is just where the State scholarship scheme, which was inaugurated after the War, did so much good; for the scholarships were generous in amount, they were not confined to localities, and they smoothed out the inequalities between place and place. Their abolition was one of the most cruel economies ever practised by a rich country in alarm at finding itself hard up. There were at the time many boys and girls, who had spent many months in preparation and study, who were on the threshold of that higher course which would give them not only their best but also their only chance of rendering their best service in life; and then in a moment fell the abhorred axe, and at a stroke robbed them of their future. It should have been not among the first but the very last economies to be put into effect. These State scholarships should be restored at the very earliest opportunity; for, as things are, they are the only means by which some really able children can obtain the education to which their abilities entitle them, and which a wise country in its own interests would see that they got.

The Board of Education is using all its influence to develop Advanced Courses in Secondary Schools, and it is acting wisely, and in the best interests of education, so far as it goes. But it is surely bad policy to take a number of able boys and girls to a point in their studies at which they can see a Promised Land stretching before them, only to be denied entrance thereto because they lack, not the will or the brains, but the money. Such clever but disappointed minds become a favourable soil for the preacher of class hatred and social discontent, and a wise statesman would be careful not to propagate them in the body politic. There is, moreover, some danger—and it is an increasing danger—that Oxford and Cambridge may become "class" universities, and that the unfortunate social cleavage which at present exists between the Public Schools and the Day Secondary schools, may repeat itself as between the ancient and the local universities. That would, if it ever came about, mean loss all round, loss to the nation as well as loss to the efficiency of universities of all types. It is not a question whether modern universities are as good as Oxford and Cambridge or better or worse; it is a question of whether we are going to have one class of the community resorting to one type, and another class to the other.

It is a commonplace to say at the present moment that the middle class is depressed, and that the stars

in their courses are fighting against it. But this class has so far in our history proved to be the great reservoir of the nation's ability, and educational help of a real and substantial character is just that which can be offered to the middle class without impairing its independence or its self-respect. For it is not a case of offering something for nothing, since from the State's point of view, value for the money expended returns in the shape of trained ability and suitably recruited public services. If it is necessary to economise in education, it is probably a false economy to starve the top, and to neglect the brains of the community; it is wiser to stint the elementary schools rather than the universities, so long as access to the latter is kept unimpaired. At present we are embarked on a doubtful experiment under which the half-educated are called upon to govern an empire, and at the same time we are not paying enough attention to our highest education. But that is a theme which requires far more space for its exposition, and it must suffice for the present to direct attention to one definite direction in which full opportunity is denied to the deserving.

Weather Forecasts.

Forecasting Weather. By Sir Napier Shaw. Second edition, revised and enlarged. Pp. xliii + 584. (London: Constable and Co., Ltd., 1923.) 36*s.* net.

THE appearance of a second edition of Sir Napier Shaw's well-known book "Forecasting Weather" affords an opportunity for a survey of the present position of the science of weather prediction.

The first synoptic charts in England were prepared in 1860 by FitzRoy, but what lessons could be learnt from a synoptic chart were then unknown and the "forecasts" and "storm-warnings" issued by FitzRoy probably merited some of the "sharp criticism" they received from the scientific authorities of the time.

After FitzRoy's death in 1865, the issue of storm-warnings and forecasts was temporarily discontinued, but the Meteorological Office continued the study of weather by means of daily telegraphic reports. By 1879 the methods of forecasting had been so far developed that forecasts were recommenced, and in 1885 Abercromby prepared at the request of the Meteorological Council his small book "Principles of Forecasting" in which the rules that had become established were described. As these rules were almost entirely empirical and drawn up after close study of daily maps for more than twenty years, they naturally contain a great mass of solid fact, and Sir Napier Shaw uses them as the basis from which he builds his exposition of more modern methods.

The leading principle in Abercromby's work was the general distribution of weather associated with typical groupings of isobars of which the cyclone was naturally the most important. To Abercromby a cyclone was a "meteor," a self-contained entity of the atmosphere having a certain distribution of winds and weather associated with it and the whole free to move. Broadly speaking, his system was to detect a cyclone on his map and then to forecast for any place in its track the normal sequence of weather changes associated with a typical cyclone. He adds, however, very plaintively: "Unfortunately, as a rule the same cyclone varies very much in shape at different periods of its existence and moves along a very irregular path, at very different rates, so that the forecaster is doomed to many failures and disappointments."

For many years forecasting consisted in little more than using the rules laid down by Abercromby. They were empirical rules, and the successful application of them therefore became more of an art than a science. There were naturally gropings after the reasons which caused the irregularities of intensity and path bemoaned by Abercromby, but with little success. Guilbert, in France, appeared at one time to have been successful in finding some of the laws obeyed by a cyclone during its erratic life, and in 1905 received a prize in a competition in practical weather forecasting in connexion with the International Exhibition at Liège for some very successful forecasts made by his method. A study of Guilbert's "rules," however, shows that they are based on no sound physical foundations, but are as empirical as Abercromby's. Guilbert's methods have not found favour with official forecasters; whether this is due to real defects of the system or to the unsatisfactory exposition given by M. Guilbert it is difficult to say.

In 1900 Sir Napier Shaw took charge of the London Meteorological Office, and in 1903 he raised the question, in a paper read before the Royal Meteorological Society, as to what travels when a cyclone crosses the country. According to the old idea the cyclone consisted of a whirl of air blowing spirally around the low pressure in the centre and when the cyclone moved the whirl as a whole moved with it. By drawing maps for every third hour during the passage of a deep and destructive cyclone, Sir Napier Shaw showed that the path of any individual air particle has no resemblance to a spiral. On the contrary, air was drawn into and ejected from the cyclonic region in a way that showed conclusively that the air does not accompany a cyclone in its motion.

The discussion on this paper is interesting reading: Dr. A. Buchan said that "he and the majority of meteorologists had believed for thirty years that the

circulation of air round storms was vortical, but he was glad to see in Dr. Shaw's paper a new point of view set forth"; and Dr. H. R. Mill thought that "the paper was not unlikely to unsettle the convictions of meteorologists concerning cyclones."

This paper was the prelude to intensive work in the London Meteorological Office on the actual motion of air in contradistinction to the apparent motion as seen on a synoptic chart. The well-known paper "The Life History of Surface Air Currents" by Shaw and Lempfert, and several papers by Lempfert and Corless on "Line Squalls," were the outcome of this phase of meteorological activity. From 1906 a cyclone has had an entirely different meaning from what it had previously, and the first blow had been struck against empirical forecasting.

While Shaw and his assistants in England were showing the unreality of the wind circulation represented on a synoptic chart, Ekholm in Stockholm was treating the pressure distribution in a similar way. Instead of plotting the actual pressure, Ekholm plotted the barometric change during the last twelve or six hours. He was then able to draw lines, "isallobars," to represent the barometric changes, and these grouped themselves into systems, very similar to the highs and lows on an ordinary synoptic chart, which he called regions of rise and regions of fall. Ekholm came to the conclusion that regions of rise and fall are not caused by the movement of cyclones and anticyclones, but are themselves primary agents; the cyclones and anticyclones being the secondary phenomena. There are many reasons for believing Ekholm to be right and that cyclones and anticyclones are only surface consequences of disturbances, probably of an entirely different nature, travelling in the upper atmosphere. Charts showing isallobars are now drawn—and published in the Daily Weather Report—but they have not proved of much assistance to the forecaster, for it is as difficult to say where a "region of fall" will move to as it is to forecast the movements of an ordinary cyclone.

The greatest step forward has been made in recent years by the staff of the Geophysical Institute, Bergen, Norway—Prof. V. Bjerknes, J. Bjerknes, H. Solberg, and T. Bergeron. The work of these meteorologists has entirely revolutionised our ideas of the "anatomy" of a cyclone. They have shown how two main currents of air—polar and equatorial—unite in a cyclone and that the boundary between them is of primary importance for determining both the development and movement of the cyclone. The two currents have different temperatures, and therefore the boundary can be easily seen and marked on a synoptic chart; and it is claimed that when this has been done it is possible to determine whether the cyclone will increase or decrease in intensity and in what direction it will move. Here at last, after nearly forty years, we appear to be getting glimmerings of light on the main problem of forecasting which has been the despair of every forecaster since Abercromby.

When one looks back over the story told by Sir Napier Shaw, one sees a period of 40 years, from 1860 to 1900, in which practically no progress was made in understanding the significance of a synoptic chart. The method was empirical and the forecasters were not trained physicists. From 1900 to 1914 Sir Napier Shaw with a few scientific assistants broke new ground and a new meaning was read into a synoptic chart. During the War great claims were made on the forecasters, and since the War, civil aviation has been insistent in its demands. This book explains how and why the science of meteorology was not found wanting in the time of need, and is an inspiration and encouragement for all those whose duty it is to forecast the weather. The book will, however, appeal to a much larger circle than that of the official forecaster; it is written in a literary style, not always met with in scientific books, which makes it delightful to read; it is well printed and profusely illustrated. There can only be one complaint, and that is with regard to the price: thirty-six shillings may be a fair price for the book, but it is a prohibitive price for many who will desire to possess a copy. G. C. SIMPSON.

Relativity and Gravitation.

(1) *The Principle of Relativity: a Collection of Original Memoirs on the Special and General Theory of Relativity.* By H. A. Lorentz, A. Einstein, H. Minkowski, and H. Weyl; with Notes by A. Sommerfeld. Translated by W. Perrett and G. B. Jeffery. Pp. ix+216. (London: Methuen and Co., Ltd., 1923.) 12*s.* 6*d.* net.

(2) *Gravitation Einsteinienne: Champ de gravitation d'une sphère matérielle et signification physique de la formule de Schwarzschild.* Par Prof. Jean Becquerel. Pp. 32. (Paris: J. Hermann, 1923.) 3 francs.

(3) *Quelques réflexions sur la Relativité.* Par P. Worms de Romilly. Pp. 59. (Paris: J. Hermann, 1923.) 6 francs.

(1) THE "Principle of Relativity" is for the most part a translation of a German collection of memoirs—"Das Relativitätsprinzip" (Teubner, fourth ed., 1922). It includes a reprint of H. A. Lorentz's Amsterdam paper (1904), as well as a translation of an extract on Michelson's experiment from his Leyden memoir (1895); further, A. Einstein's fundamental papers on the restricted theory of relativity (1905) and

the general theory of relativity (1916), as well as his shorter papers on inertia and energy (1905), Hamilton's principle (1916), cosmological considerations and the gravitational field (1917), and gravitational fields and the structure of matter (1919); then H. Minkowski's lecture on space and time to the assembly of German Men of Science and Physicians (1908); and finally H. Weyl's paper on gravitation and electricity (1918).

Clearly, the collection is a very representative one and is certain to prove useful to the English student of the theory of relativity; nevertheless, it seems a pity that, on one hand we possess no English translation of such fundamental and at the same time inaccessible papers as those of Poincaré ("Sur la dynamique de l'électron," 1906) and of Levi-Civita ("Nozione di parallelismo," "Statica Einsteiniana," etc., 1917–1919), whilst on the other there is overlapping between the present collection of translations and that of Saha and Bose (Calcutta, 1920). These two collections have the two fundamental papers of Einstein as well as the lecture of Minkowski in common, whilst Saha and Bose give in addition a translation of Minkowski's great paper on the (restricted) principle of relativity (1909). It would be a great advantage for the student if the present translators, or others equally well qualified, could be induced to publish a third collection of papers, including those of Poincaré and Levi-Civita already mentioned, together with such papers as those of Born (1909) and Herglotz (1911) on elasticity in the restricted theory, H. A. Lorentz (1915–1916) on Hamilton's principle, D. Hilbert (1917) on the foundations of physics, to mention only some of the most important and inaccessible ones.

The fundamental papers of Lorentz and of Einstein no doubt need no mention here, as they will be sufficiently well known to physicists; attention may, however, be drawn to the valuable notes by Sommerfeld appended to Minkowski's lecture. The remaining four short papers by Einstein are of great interest, especially the last two. The first of these two gives the theory of Einstein's finite cylindrical world; the second, to some extent based on the former, propounds a theory of the constitution of matter, which is intended as an improvement upon the theories of Mie, Hilbert, and Weyl, in so far as it indicates "the possibility of a construction of matter out of gravitational field and electromagnetic field alone." In the last paper of the collection Weyl gives a sketch of the general principles of his theory of the gravitational and electromagnetic field, which is developed more fully in his memoirs of 1917 and 1918 and in his book "Space, Time, and Matter," an English translation which was issued in 1922 by the publishers of the volume before us.

The present translations are excellent, accurate, and idiomatic; the printing is clear, even as regards the small suffixes, and is remarkably free from misprints. Altogether the book constitutes an indispensable part of a library on relativity.

(2) Prof. Jean Becquerel's tract may be regarded as an extension of the third part of Ch. XIV. of his book "Le Principe de Relativité et la théorie de la gravitation" (1922). It gives an exceptionally clear account of the problems connected with the spherically symmetrical gravitating field, and deals amongst other matters with the solutions of Schwarzschild and the criticisms of Painlevé, the metrics of Schwarzschild's continuum outside and inside a homogeneous gravitating sphere, the isotropic co-ordinates of Eddington, and the effect of world-curvature. It can be highly recommended because of the lucid discussion of the principles involved, especially as regards the determination of the metrical properties of the field.

(3) M. Worms de Romilly's tract gives a concise summary of the argument and conclusions of the theory of relativity, about ten pages being devoted to the restricted theory, twenty-five to the general theory, and ten to the tensor calculus and some of its applications. In general, for the sake of brevity, formulæ are quoted without proof, and the treatment altogether is that of a commentary rather than a treatise; indeed nothing more is possible in so restricted a space, and the author claims no more. Unfortunately the work is marred by numerous misprints; this fact, together with the conciseness of the treatment and the absence of references, makes it difficult to read and unsuitable as an introduction to the subject. The last ten pages include a critique of the fundamental principles of the theory; this portion is particularly interesting because it gives the considered opinion of a competent but unprejudiced bystander. Anyone with a sufficient knowledge of the theory will no doubt benefit considerably from a perusal of this suggestive memoir.

Forests of the Gold Coast.

The Forest Officers' Handbook of the Gold Coast, Ashanti, and the Northern Territories. By T. F. Chipp. (Published for the Government of the Gold Coast.) Pp. 149. (London: Crown Agents for the Colonies, n.d.) 10*s.* net.

VERY little has been hitherto published concerning the forests of the Gold Coast and its dependencies; and we welcome this book, which presents the known facts in a handy form for the use of forest officers. It contains in addition a record of original work on the ecology of the forests, and their intimate relation with the climate and soils which

prevail in the Colony. The subject is introduced by a chapter on West African forests in general, which directs attention to the gradual desiccation of the whole region south of the Sahara in recent times. This has a serious bearing on the necessity for improvement in the native practice of agriculture and for the establishment of forest reserves by the Government.

The descriptions of the natural features, climate, and forests of the colony are elucidated with sketch maps and diagrams. The amount of precipitation determines the three types of forest: the evergreen forest, rainfall 72-88 inches; the deciduous forest, average rainfall 52 inches; and the savannah forest, rainfall 36-47 inches. The evergreen forest consists of three tiers of trees, the uppermost tier forming close canopy, while all the stems are interlaced with innumerable woody climbers. In the deciduous forest there are two tiers of trees, the lowermost tier forming close canopy, while the dominant trees above it have almost isolated crowns. The savannah forest consists of trees scattered amid grass. The deciduous forest is the richest in valuable timbers. Both in it and in the evergreen forest, nearly all the big trees are buttressed at the base; and the shape of the buttress is constant in each species. The trees when felled are cut above the buttresses, large stumps 8-12 feet high being left, so that much valuable material is wasted.

There are no State forests in the Colony, all the land being owned either by communities or families; but the right to grant concessions for taking timber, while vested in the owners, is controlled by Ordinances. The forests yield valuable products in addition to the timber, as cola nuts, palm kernels, palm oil, rubber, and copra.

All the forest ordinances and regulations are given in full in a special chapter, and the book also contains useful lists of the numerous forest products and of native names of the principal trees. In an appendix, 20 plates illustrating the leaves, flowers, and fruits of the more important species are reproduced from Mr. H. N. Thompson's official report on the forests of the Gold Coast, issued by the Colonial Office in 1910.

A Polemic against Mechanism.

An Outline of Psychology. By Prof. William McDougall. Pp. xviii+456. (London: Methuen and Co., Ltd., 1923.) 12*s*. net.

PSYCHOLOGY to-day is in doubtful case. It has been struggling for some years to free itself from the suzerainty of philosophy, and now, before the issue is quite decided, it has to turn round and resist the aggressiveness of physiology. The professed psychologist leads a precarious existence, and only by playing off one enemy against the other. He is looked upon with suspicion by both.

Prof. McDougall can justly claim to be a physiologist, but he would rather be a philosopher, and in the present work he has definitely chosen his side, and shows himself the avowed opponent of all who would bring mind under physiological (and ultimately chemical and physical) laws. For better, for worse, his science must somehow be squared with what William James would have called a tender-minded philosophy.

Hence the violence of his "polemic" (the word is his own) against mechanism. Mechanism in the biological sciences, if carried beyond them, may result in a view of the world and of man's place in it which Dr. McDougall finds most unwelcome, blasphemous even. He therefore sets out to shout the mechanists down. He calls them names: behaviorism, for example, is "a misshapen and beggarly dwarf" begotten on physiology, by a father unspecified. Then, having recovered his temper for the nonce, he goes on more soberly and persuasively, with a wealth of example and a splendid lucidity of treatment, to show that the most fundamental category in psychology is *purpose*, and that mechanical laws will not account for the facts of human and animal behaviour.

The main argument against mechanism in psychology turns on method. Mechanism is an unfruitful method, because it is unduly restrictive. It narrows down the field of investigation. This would not matter so much if our knowledge within that field were already full and trustworthy. But it is nothing of the kind. Our knowledge of physiology, especially of the physiology of the nervous system, is still only a thin veneer laid over ignorance. Let us press on as eagerly as may be to the increase of this knowledge; but, in the meantime, let us leave psychology free to pursue its own untrammelled course, along different lines. Let us, as psychologists, continue to use the old, established terms, like "mind," "consciousness," "thought," "emotion," "attention," "memory," etc., doing our best to make their connotation ever more precise; and let us do all this frankly for pragmatic reasons. Such a method *works* better in our present state of half-knowledge, than, for example, the behavioristic method, which banishes "mind" and "consciousness" from the vocabulary of psychology, and treats "thought" as nothing but speech mechanisms.

Prof. McDougall states this main argument against mechanism admirably, and, had he let it rest there, would have secured a wide measure of agreement among contemporary British and American psychologists. This is as far as the psychologist need go, and so long as he remains with his feet firmly planted on the ground of method he is, we believe, unassailable. But there is

the further question, which is really a metaphysical one, and is central in such recent works on metaphysics as Prof. Alexander's "Space, Time and Deity" and Prof. Lloyd Morgan's "Emergent Evolution"; the question, namely, whether mind is from its very nature inexplicable in mechanical terms. Prof. McDougall might have been better advised to leave this question open. His discussion of it is largely rhetorical.

Another, less crucial, example of Prof. McDougall's philosophical (or shall we say metapsychological?) leanings is to be found in his treatment of the issue raised by the Freudians between the sexual and the parental instincts. He is an ardent devotee of the parental instinct and the "tender emotion" associated with it. It was, he says, the mammalian "invention" of this instinct, wholly distinct from and varying independently of the sexual instinct, "which alone rendered possible the development of a highly intelligent species, such as *Homo Sapiens*, and which also gave to his nature, conduct, and institutions all that is truly admirable in the moral sense" (p. 131). To merge the sexual and parental instincts, as the Freudians do, would seem to remove the only solid ground for altruism in ethics and the higher life of mankind. This is, no doubt, an appalling prospect; but, even after all the extravagances and hasty assumptions of the Freudians have been eliminated, there remains a striking body of evidence for their view that the phenomena of parental love are ultimately of sexual origin. There is matter for argument, at any rate, and any psychologist who sets out to take a comprehensive view of his subject must sift and examine this evidence or lay himself open to the easy psycho-analytic charges of prejudice and prudery. Prof. McDougall dealt with this issue in a supplementary chapter to the fourteenth, revised, edition of his "Social Psychology," but he was certainly called on to deal with it again in the present work. Instead of that, he merely refers contemptuously to the Freudians in footnotes, and betakes himself to the easy comfort of affectionate pigeons. The parental or protective instinct, which is central in his system, wobbles in a mist of sentimental phrases.

It is greatly to be regretted that the flaws in this book tend to obscure its great merits. Prof. McDougall has restated his position on the vexed questions of instinct and intelligence in man, of emotion as the qualitatively different, subjective aspect of instinctive behaviour, and of the inadequacy of the pleasure principle as a motive to action, in a way that could scarcely be bettered. Some of us, of the younger generation in psychology, tend perhaps to kick against the strength of the McDougall tradition, but, when we are honest, we have to admit that most of the fruitful ideas which we possess derive directly from him. J. Y. T. GREIG.

Morphological Constituents of Algal Cells.

Archives de morphologie générale et expérimentale. Fascicule 9 (*Histologie*): *Recherches sur les constituants morphologiques du cytoplasma des algues.* Par Dr. G. Mangenot. Pp. ix+330+16 planches. (Paris: Gaston Doin, 1922.) 30 francs.

IN recent years it has been shown, with the aid of improved methods of fixing and staining, that, in addition to nuclei, centrosomes, plastids, etc., there are certain other morphological constituents of the cytoplasm which have well-defined characteristics, and appear to be of general occurrence in both animal and vegetable cells. These are minute granular structures known under various names as chondriosomes, mitochondria, chondrioconts, etc., which occur in the form of granules, rods, filaments or vesicular structures scattered about in considerable numbers in the cytoplasm, and forming collectively what is known as the chondriome element of the cell. The chondriosomes are held by many observers to be of great physiological importance, and have been credited with various functions in connexion with the transmission of hereditary characters, metabolic activities, and the formation of the chromoplasts.

In the work under review an exhaustive account is given of these organs as they occur in the Algæ. The author has found them to be of general occurrence both in the vegetative cells and in the reproductive cells of the green, brown and red Algæ, existing side by side with the chromoplastids, in the form of granules, rods and filaments, indistinguishable in many respects from the colourless plastids, and like them transmitted from cell to cell by division. From a consideration of the very remarkable variability of the plastids at different stages in the life of an algal cell, the author concludes that they must be of the nature of mitochondria, but not that all mitochondria are plastids. In agreement with a suggestion already made for the higher plants, the author considers that there is sufficient evidence to show that there are two categories of chondriosomes in the Algæ, one destined to give rise to the chromoplastids, and the other possessing functions which are still unknown. These exist side by side, and together form the chondriome of the cell.

In the course of his investigations the author points out that chondriosomes must not be confused with such structures as vacuoles, or with the proteid, metachromatic or lipoid bodies commonly found in cells; he also adds something to our knowledge of certain constituents known as physodes and fucosan granules in the Phæophyceæ.

Dr. Mangenot is to be congratulated upon this important contribution to a difficult subject. His memoir

is well written and well illustrated, and contains a full account of a large number of detailed observations, but, as he would probably be willing to admit, there is much yet to be done before we can arrive at anything like really satisfactory conclusions on the morphological nature of the chondriosomes or the part played by them in the vital activities of the cell. In particular, it is much to be desired that the relation of the chondriome to the Golgi apparatus and to the chromidial apparatus should be more clearly defined than has yet been done. H. W.

British Hemiptera-Heteroptera.

A Biology of the British Hemiptera-Heteroptera. By E. A. Butler. Pp. viii+682+7 plates. (London: H. F. and G. Witherby, 1923.) 63*s.* net.

SINCE Saunders published his "Hemiptera-Heteroptera of the British Islands" in 1892 much knowledge has accumulated relating to "bugs," and Mr. Butler deserves well of biologists that he has brought this together in so attractive a form as his recently published volume. Prefacing the main body of the work is an interesting introduction, wherein is discussed among other subjects the wing reduction seen in many species. As an alternative to Mr. Butler's explanation it may be suggested, perhaps, that apterous and vestigial winged forms have arisen among "bugs" in the same way as they have been found to arise among fruit flies, and if that is so the question of "purpose" scarcely calls for comment.

The curious host distribution of these insects is indicated and treated more fully in an appendix. Why some twenty-two totally unrelated natural orders of plants should be entirely avoided, and others equally unrelated prove more or less attractive, is indeed a puzzle and offers a fine field for research. The body of the volume is a very complete treatment, so far as is known, of the Heteroptera occurring in the British Isles; each of the four hundred and sixty-two species being dealt with under the headings, ova, larvæ, life cycle, habitat, etc., and distribution. Looking through the accounts one realises how little is known of the early stages of most of these insects, and how essential it is that detailed life-history studies should be carried out under exact and controlled conditions.

The volume contains a bibliography extending to seventeen pages, and the author may be justly proud to include sixty-four of his own contributions. A number of appendices follow, of which the first is a useful list of British Hemiptera-Heteroptera arranged according to Oshanin's Catalogue of 1912. It may be remarked that throughout the volume the nomenclature in general adopted is that of the latest British Catalogue (1908). This does not coincide with Oshanin's Palæarctic Catalogue, which is used on the Continent and elsewhere, but in all instances the changes that would be necessary to bring the two into accord have been noted.

A second appendix gives in a very convenient form and in monthly detail the seasonal distribution of the Heteroptera; while following this is a tabulation by counties of their geographical distribution. The work concludes with an index of plants and their Hemipterous visitors and a general index. Mention may also be made of a short but extremely useful table to aid determination of families in larval forms of the non-aquatic Heteroptera.

The volume is illustrated by three plates of nymphs beautifully coloured by the author, a fine series of photographs in four plates, and fifty-three text figures. No misprints have been noted and the book is well produced. Altogether the volume is a tribute to very fine scholarship and will immediately take its place as a standard work to rank with Verrall's Stratiomyidæ, Cameron's British Phytophagous Hymenoptera, and the few others of like calibre.

Our Bookshelf.

Aristotelian Society. Supplementary Vol. 3: *Relativity, Logic, and Mysticism; the Papers and Symposia for Discussion at the Joint Session of the Aristotelian Society, the Mind Association and the Scots Philosophical Club, Durham, July 13th-16th,* 1923. Pp. ii+184. (London: Williams and Norgate, 1923.) 15*s.* net.

AN article by Prof. Léon Brunschvicg in this volume, entitled "The Relation between the Mathematical and the Physical," is a most important attempt to appreciate the significance of the relativity principle in physics. In his view it alters completely the status hitherto assigned to mathematics, that of a formal abstract science dependent on physics for its material. The often-quoted saying of Mr. Russell that in mathematics we never know what we are talking about or whether what we are saying is true, no longer applies if we accept the theory of relativity. Physics is wholly dependent on mathematics for its subject matter. "The problem of mathematical physics has definitely and radically changed its meaning: it no longer needs to impose the apodeictic form of geometry on the world, but to adapt a certain type of geometry to the indications which the universe furnishes on its own account."

Closely connected with this subject is the symposium by Prof. Wildon Carr, Dr. R. A. Sampson and Prof. A. N. Whitehead on the "Problem of Simultaneity." Prof. Wildon Carr argues that the paradox of the voyage in the cannon-ball, in which the Lorentz contraction shows that there is a discrepancy between two times measured by synchronous clocks, is a true "antinomy of reason" and only to be reconciled by a criticism of the scientific postulates. Dr. Sampson argues that the order of sequence and causation in physics makes it necessary to assume that the paradox is an expression of our partial and limited modes of apprehension.

Prof. Whitehead argues that science cannot and need not give up the fundamental character of simultaneity. He regards the paradox as belonging to the realm of curious tricks of personal psychology, and protests against the "bifurcation of Nature."

Another symposium of scientific interest is that on "The Relations between Biology and Psychology." Dr. Haldane maintains that the perceived world is a psychological world and therefore a world of personality, but that it is not a world of individual personality. The physical world is an abstraction from the personal world. To argue that a man's personality depends on his body amounts to maintaining that he depends on an abstraction from himself. Dr. E. S. Russell contends that once we drop the materialistic conception we must swing over into the monadistic theory, and this is ultimately based on the immediate experience of ourselves as psychical individuals. Sir Leslie Mackenzie maintains that personality is just as much an abstraction as mechanism. He also challenges the validity of the expression "organism as a whole." The remaining articles are on logical and metaphysical problems.

Gas Manufacture. By Dr. W. B. Davidson. Pp. viii+464. (London: Longmans, Green and Co., 1923.) 21*s.* net.

THIS volume attempts a presentation of very much more than its title would lead one to infer; it sprawls over the manufacturing, distributive, and legislative aspects of towns' gas. Contrary to the author's expressed intention, the mechanical and not the chemical aspect of gas manufacture receives the greater prominence in the work. Thus, whilst eighteen pages are devoted to the chemistry of high and low temperature carbonisation, and eight to the chemistry of water-gas production, we find one hundred pages devoted to the description of carbonising plant, *et hoc genus omne*. Other chemical subjects discussed in the work include the gas laws, the constituents of coal gas, the materials of coal gas manufacture, residuals and analytical methods, whilst sections predominantly mechanical are devoted to condensation, gas purification, washing and storage, labour-saving appliances. Pyrometry and refractories are treated in a very inadequate five pages.

Special contributors are responsible for the sections on gas distribution, gasholders, retorts and retort settings. That on gas distribution proceeds along hackneyed lines, and does scant justice to the scientific principles involved. A certain amount of overlapping in the separate contributions is evident, *e.g.* pp. 17, 286; and pp. 43, 331. Occasionally there is an apparent absence of agreement in duplicated statements made by the same contributor, *e.g.* pp. 80 and 82. Truly has it been said "paper is very patient."

We regret the low esteem in which the author apparently holds the university-trained gas chemist and the "ordinary" teacher (p. 19), and wonder what the author himself does in that galley. We confess ourselves disappointed with the contribution made by so eminent a member of the profession to the literature of gas technology. A later edition will doubtless see considerable improvement in the work. In the meantime we commend the scattered references to calorimetric matters contained in the volume. J. S. G. T.

The Chemical Elements. By F. H. Loring. Pp. ix+171. (London: Methuen and Co., Ltd., 1923.) 8*s.* 6*d.* net.

MR. LORING'S work on the chemical elements is, like its predecessor "Atomic Theories," a distinguished piece of amateur work, and will be of interest to research-workers in these subjects, although its shortness, disjointedness, and, at times, lack of sound judgment, unfit it for unqualified use by students. "Amateur" is used advisedly and without offence, because it is plain that the author has not always thought out matters for himself; he does not write like one inside the subject. This is shown by his uncritical respect for authority and by his putting forward new and good ideas at the same time that he is expatiating upon the dullest of commonplaces. He does not always get behind his numerical relationships in the Periodic Classification to see how important or how trivial are their consequences.

The book is neither a text-book nor a monograph, but essentially an original contribution to the subject. It includes chapters on the quantum theory, on the theories of Bohr, of Langmuir, and of Kossel, and accurate summaries of the facts of such subjects as the isotopes of inactive elements, and of radioactivity; but the author's point of view and his ideas are kept before the reader throughout. In a more original chapter the author describes his "wedge" periodic table of the elements; in another he points out the significance of the rarity of the element scandium, and in a third, but without working out its consequences, he puts forward the good idea that the α-particle in radioactive change may result from its formation from hydrogen nuclei.

A number of appendices form one quarter of the book, and these deal with such subjects as the synthetic production of elements, the recent work of Dr. Aston, and a possible element of atomic number zero.

(1) *The Determination of Hydrogen Ions: an Elementary Treatise on the Hydrogen Electrode, Indicator and Supplementary Methods, with an Indexed Bibliography on Applications.* By Prof. W. Mansfield Clark. Second edition. Pp. 480. (Baltimore, Md.: Williams and Wilkins Co., 1923.) 5 dollars.

(2) *Der Gebrauch von Farbenindicatoren: ihre Anwendung in der Neutralisation-analyse und bei der colorimetrischen Bestimmung der Wasserstoffionenkonzentration.* Von Dr. I. M. Kolthoff. Zweite, verbesserte Auflage. Pp. ix+220. (Berlin: Julius Springer, 1923.) 10*s.* 7*d.*

(1) THE second edition of Clark's book on "The Determination of Hydrogen Ions" shows the results of a further exploration of the very wide field over which work on this subject is scattered, since in addition to making important changes in the text, the author has increased the number of references from 1100 to 2000. In the preface he makes the interesting suggestion that instead of writing the awkward symbol pH, where the H is really a capital subscript to a small p, the alkalinity of a solution should be expressed by the same numbers but under the designation of °S (degrees Sørensen).

(2) With this may also be noticed the second edition of a work in German by a Dutch author dealing with the colorimetric method of determining hydrogen ions. This is a small book, in seven chapters, which can easily

be slipped into the pocket. It is evidence of the growing importance of this method of investigation that Dr. Kolthoff is able to give a list of 41 indicators, ranging from methyl violet to nitramine and Poirrier's blue covering a range of alkalinity from P_H 1 to 13, whilst a "stop-press" slip in Dr. Clark's book records the properties of 5 additional new indicators.

Kurzes Lehrbuch der Chemie in Natur und Wirtschaft. Von Prof. C. Oppenheimer. *Nebst einer Einführung in der Allgemeine Chemie.* Von Prof. J. Matula. Pp. xx+862. (Leipzig: Georg Thieme, 1923.) 25*s*.

THIS remarkable book contains in a single volume (i.) an introduction to general chemistry, covering 258 pages, contributed by Prof. Matula of Vienna, (ii.) a section on inorganic chemistry, covering 325 pages, (iii.) a section on organic chemistry covering 483 pages of the volume. Under these conditions a considerable measure of compression has been necessary. On the whole, this has been carried out judiciously, since most of the interesting topics in chemistry are referred to. It is, however, surprising that the largest number of entries in the name-index is under Neuberg, whose work in physiological chemistry, which is almost unknown to workers in pure chemistry, receives 46 entries, as compared with 36 under E. Fischer, 28 under von Baeyer and under Willstätter, and 18 under Werner. This is, however, less remarkable than the single entries only under the names of Bragg, of Pope (a reference to optically active compounds of tin), and of Walden (a reference to liquid sulphur dioxide as a solvent), and the complete omission of the familiar names of Lapworth, Lewis, and Langmuir.

As is usual under such high compression, illustrations are very scarce, but one of these is a crude picture showing the three principal zones of a candle-flame, which might surely have been left to the imagination. Since, however, there is no book of similar scope published in Great Britain, a chemical student who wishes to learn German might do much worse than practise the language, and, at the same time, acquire a knowledge of chemistry from a German point of view, by working steadily through this big volume.

Y a-t-il continuité dans le monde physique? Par Nicolas Yermoloff. Pp. x+48. (Paris: Gaston Doin, 1923.) 3.50 francs.

IN this memoir M. Yermoloff applies Cantor's theory of number to problems of evolution with the object of deciding whether the processes of evolution have been continuous, connex, or discontinuous. He regards the successive generations of a natural order, such as the Diatomaceæ, as an aggregate which can be treated by Cantor's methods. If there be continuity, this aggregate is infinite and non-enumerable, and its power is 2^{N_0}, where N_0 denotes Cantor's smallest transfinite cardinal number Alef-zero; if there be connexity, the aggregate is infinite, but enumerable, and its power is N_0; if finally there be discontinuity, the aggregate is finite, and its power is the total number of generations. With the last alternative the time required for the evolution of a given variety will be finite, but with the other two infinitely great, and much more difficult to account for. Thus the conclusion is reached that evolution has taken place by step-by-step "mutation" rather than by continuous, or even connex, "variation." If any criticism is to be offered of this interesting and suggestive memoir, it is that few of the biologists for whom, presumably, it is intended are likely to possess a sufficient knowledge of higher mathematics to appreciate the argument fully, in spite of the fact that quite one-half of the memoir is devoted to an exposition of Cantor's methods.

Practical Least Squares. By O. M. Leland. Pp. xiv+237. (New York and London: McGraw-Hill Book Co., Inc., 1921.) 15*s*.

THERE are already many excellent books on least squares, both theoretical and practical, but there are also many differences between the requirements of one student and another, and this book may well find a place. Its limitations of aim are clearly stated in the preface, the special object being to provide an elementary course in which practice is obtained first and reasons are supplied later. The body of the book contains, therefore, a description of the customary calculations, with relatively lengthy treatment of conditioned observations and triangulation, but with all discussion of precision relegated to the end. This is unusual, and the actual method of calculating the standard (mean square) error, working with an assumed base, is not given, although this method is used for calculating the mean itself. Also no direct reference is made to the minimum property of the standard error. The use of the normal law of error is justified in an appendix by Gauss's first proof, but in a course of this sort one might have expected to find more use made of actual sets of data to illustrate in detail the relation between theory and fact. The treatment is attractive and clear, but there are no examples for practice.

British Earthworms and How to Identify Them. By Hilderic Friend. (How to Identify Series, No. 18.) Pp. 64. (London: The Epworth Press, n.d.) 1*s*. 6*d*. net.

IT is to be hoped that the publication of this admirable and remarkably cheap little book from the pen of an expert will lead zoologists to devote more attention than hitherto to this rather neglected section of the British fauna. Mr. Friend uses "Earthworms" in a wide sense, including in his account the three families (i.) Lumbricidæ, containing eight genera and thirty-seven species, (ii.) Glossoscolecidæ, with two genera and three species, (iii.) Megascolecidæ, of which *Microscolex phosphoreus* is our sole representative. The illustrations, "keys," and tables of species in the several genera render the work of identification of specimens a comparatively easy task: while the book is so small and light that it can be carried in the pocket without inconvenience.

A Study of American Intelligence. By Prof. Carl C. Brigham. Pp. xxv+210. (Princeton: Princeton University Press; London: Oxford University Press, 1923.) 16*s*. net.

THE study is based on the data relative to intelligence and nativity published in the official report of psychological examining in the United States Army. The writer was at first attached to the psychological department of the Canadian Government, but he accepted an appointment in the United States Army when America entered the War.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Refractive Index of Gums and a Simple Method of determining Refractive Indices.

MANY microscopists must have had occasion to use the highly refractive gum-styrax as a medium for mounting. The genus Styrax is, I believe, native in Western Asia and Asia Minor, but which of the species furnishes the gum, or how the gum is collected and prepared, I do not know and should be glad if any of the readers of NATURE could supply information on these points.

The refractive index of the gums as sold is not far from 1·8—far in excess of that of any other organic product with which I am acquainted.

In connexion with some work on the refractive indices of organic structures, I have recently measured the indices of a considerable number of gums and their solvents by a method described below. Some of the results are here given. It appears that no fluid (at least no fluid in ordinary use) has a lower refractive index than water ($\mu = 1{\cdot}333$). For a large number, μ lies between 1·35 and 1·45; for most of the gums soluble in alcohol, ether, or benzole $\mu > 1{\cdot}45$ and $< 1{\cdot}55$, and for a few $\mu > 1{\cdot}6$. Between these and the μ for styrax there is a large gap which I have not been able to fill.

μ FOR VARIOUS SOLIDS AND LIQUIDS.

Solvents.	μ.	Gums.	μ.	μ as computed for solid gum.
Water	1·333	*Cherry gum	1·344	1·45
Ether	1·360	*Acacia gum	1·372	1·47
Acetone	1·360	*Gum Arabic	1·370	1·48
Alcohol	1·365	†Sandarac	1·520	
Amyl acetate	1·410	†Storax	1·540	
Chloroform	1·450	†Damar	1·560	
Benzole	1·530	†Copal	1·560	
Cedar oil	1·570	†Kauri	1·570	
Xylol	1·540	†Shellac	1·655	
Miscellaneous.		§Bensoin	1·610	
Treacle	1·58	§Guiacum	1·630	
Cane sugar	1·60	‡Styrax	1·810	
Albumen	1·38			
§Artist's copal varnish	1·57			

* Thick solution in water. † Gum melted in prism.
§ Thick solution in benzole. ‡ As sold.

The plan adopted in making these measures is indicated in Figs. 1 and 2. The slit S is mounted on the substage of the microscope and brought into the focus of a low-power objective O. An acute-angled prism P is formed by cementing a small piece of glass G to one end of a strip of thin glass and resting this on a glass slide which is placed on the stage (Fig. 2 (*a* and *b*)). The fluid to be examined, F, is run under the thin glass in sufficient quantity to fill about a tenth of an inch of the thin end of the prismatic space between the thin glass and the slide. The slide is moved about on the stage until two images of the slit appear in the field. One of these images, I (Fig. 2 (*c*)), is formed of pencils which pass through the slide only, the other, I_2, by the pencil refracted through the fluid prism. The distance between the two images is measured by a micrometer eyepiece E (Fig. 1), and supplies the data requisite for the determination of the refractive index of the fluid, provided that the corresponding measurement for some fluid of known refractive index has also been made. If n_x is the micrometer reading for a fluid the refractive index of which is μ_x it can easily be shown that $\mu_x = \frac{1}{1 - cn_x}$, and that if n_a is the corresponding reading for a fluid the refractive index of which is known the constant $c = \frac{\mu_a - 1}{\mu_a n_a}$.

Thus
$$\mu_x = \frac{1}{1 - \frac{\mu_a - 1}{\mu_a}\frac{n_x}{n_a}}.$$

Several of the gums examined could be fused in the prism and the refractive indices of the solid determined directly; in other cases solutions had to be used and the refractive indices the solids deduced from that

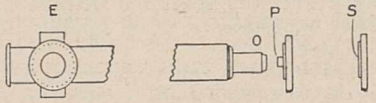

FIG. 1.—General arrangement of the parts of the apparatus: S, slit; P, prism; O, objective; E, micrometer eyepiece.

of the solutions. In a true mixture (*i.e.* a mixture in which the components have no chemical action on one another) of volumes a_1, a_2, etc. the refractive indices of which are μ_1, μ_2, etc., the refractive index of the mixture is $a_1\mu_1 + a_2\mu_2 + \ldots / a_1 + a_2 + \ldots$. If only one solid and one solvent are involved and the refractive index (μ_2) of the latter is known, and if also μ_s is the refractive index of the mixture and $a_1/\overline{a_1 + a_2} = \text{P per cent.}$, then
$$\mu_1 = \mu_2 + \overline{\mu_s - \mu_2}/\text{P}.$$
This relation was used in computing the values for the water-soluble gums when in the solid state.

The above described plan of measuring refractive indices has several advantages. The only measurement to be made is the reading of the eyepiece micrometer, and very small quantities of fluid (about as much as can be carried on the head of a stout pin) are sufficient to charge the prism. The accuracy is amply good enough if only the average refractive index is required, but it may be added that in those substances where the dispersion was large the observations refer to the yellow-green (between the D and E lines).

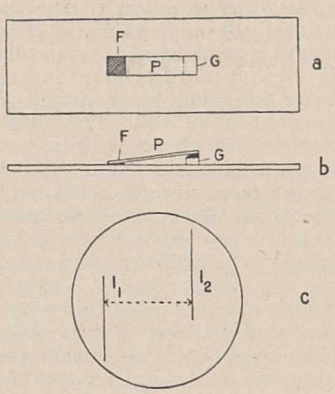

FIG. 2.—Liquid Prism. (*a*) plan, (*b*) section, of slide and prism g, small piece of glass cemented to the thin glass slip P. F, fluid under examination; (*c*) appearance in the field of the microscope of the direct image I, and refracted image I_2 of the slit.

A small correction of the micrometer reading should be made in order to allow for the lateral shift of the virtual image of the slit due to the thickness of the upper plate of the prism. This correction, which has the effect of increasing the refractive indices as observed, might be avoided by introducing a collimating lens between the slit and the prism.

A. MALLOCK.

9 Baring Crescent, Exeter,
December 21.

Scattering of X-ray Quanta and the J Phenomena.

IN NATURE of November 17, p. 723, Prof. Barkla discusses the transformations of X-rays during scattering and transmission through matter, with particular reference to my recently proposed quantum theory of X-ray scattering. Permit me to present my apology to Prof. Barkla for not referring to the work done on this subject by himself in 1904 (*Phil. Mag.* 7, 550), and by Beatty in 1907 (*Phil. Mag.* 14, 604) working in his laboratory. This early work was not mentioned because of later statements of his, such as, "the scattered radiation differs inappreciably in penetrating power from the primary radiation, that is to say, there is no appreciable degradation accompanying the process of scattering" (Barkla and Ayers, *Phil. Mag.* 21, 271, 1911). These statements led me to think that Barkla judged the differences between the primary and the scattered X-rays observed in these earlier experiments to be smaller than the experimental error.

Prof. Barkla and I agree upon the fact that the secondary X-rays from light substances are usually less penetrating than are the primary rays. Our difference lies chiefly in the interpretation of this softening. Barkla adheres to Thomson's classical theory of scattering, according to which the wave-length of the scattered beam is identical with that of the primary beam. To account for the observed difference between the primary and the scattered X-rays, he supposes that some undefined transformation occurs, subsequent to the scattering, during the transmission of the scattered radiation through the radiating substance and through the absorbers. On this view the change in penetrating power of the secondary rays is not immediately produced by the scattering, but becomes evident only after the scattered rays have traversed an appreciable thickness of matter.

My interpretation of the softening differs fundamentally from Barkla's in that the change of wave-length is considered to occur when the ray is scattered. If a quantum of primary X-rays is scattered in some other direction by a single electron, the change in momentum of the X-ray results in a recoil of the electron, which takes up a part of the energy of the X-ray quantum. Thus the energy, and hence also the frequency of the deflected radiation quantum, is less than that of the primary ray, and the wave-length is correspondingly greater. If, however, the primary quantum is scattered by a group of electrons the combined mass of which is relatively great, no appreciable energy is taken up in their recoil, and no appreciable change in wave-length results.

My recent spectroscopic measurements of the X-rays scattered by graphite (paper Am. Phys. Soc., Apr. 28, 1923; *Phys. Rev.* Nov. 1923) separate the scattered molybdenum K_α ray into two components, one of accurately the same wave-length as the primary, and the other of increased wave-length, due presumably to scattering by groups of electrons and by single electrons respectively. The wave-length change of the modified ray varies from 0·007 Å at 45° to 0·041 Å at 135°, in accurate accord (±0·001 Å) with the quantum theory. These results have been beautifully confirmed and extended by the photographic spectra obtained by P. A. Ross (Proc. Nat. Acad. July 1923; *Phys. Rev.* Nov. 1923). These spectra show both the modified and the unmodified lines for the rays scattered at various angles by elements over a wide range of atomic numbers, and in each case a wave-length change for the modified line in accurate agreement with the theoretical formula.

As an explanation of the change in penetrating power, Barkla's "J" transformation is obviously less complete than is this quantum theory, since it says nothing regarding the mechanism of the transformation and makes no prediction regarding the magnitude of the change.

Barkla attempts to disprove the existence of the recoil electrons which result from my theory of scattering by a consideration of the relative ionisation in hydrogen and air. He quotes Shearer's estimate (*Phil. Mag.* 1915) of 0·0016 as an upper limit of this ratio when the K-rays from tin are used, and calculates from my formula a value "of the order of 0·01," which does not agree well. Using Hewlett's absorption data (*Phys. Rev.* 1921) for calculating the ionisation of air, and taking $\lambda_{K\alpha} = 0{\cdot}487$ Å as the wave-length of the tin rays, I calculate from my formula the ratio of the energy spent in producing ionisation in hydrogen to that spent in air, per unit volume, has the value 0·0040. If low-speed electrons in hydrogen produce the same ionisation per unit energy as do high-speed electrons in air, this figure represents also the relative ionisation to be expected in the two gases. A similar calculation for copper ($\lambda = 1{\cdot}484$ Å) gives the ratio 0·00005.

As an average of all his measurements Shearer found the values of this ratio to be for tin K rays, 0·0035, which is close to the theoretical value; and for copper, 0·0018. Suspecting that a considerable part of the observed ionisation in hydrogen was due to impurities, Shearer estimated the ratio 0·0016 for the tin rays on the basis of the three lowest observed values. Since Shearer's experimental values for the tin rays vary between 0·0009 and 0·0063, and for the copper rays between 0·0003 and 0·0031, it appears that the differences between the values calculated from the quantum theory and those observed in Shearer's experiments are within the probable experimental error.

On the other hand, very direct evidence for the existence of the recoil electrons is afforded by Wilson's and Bothe's recent cloud-expansion photographs. Wilson concludes (Proc. Roy. Soc. 104, 24, 1923), referring to his "fish" tracks, that "Their direction and range, and the value of the minimum frequency of the radiation which is required to produce them, are in agreement with the suggestion made by A. H. Compton, that a single electron may be effective in scattering a quantum of radiation, and that in so doing it receives the whole momentum of the quantum." Moreover, the relative number of "fish" tracks and of long-range tracks which appear in these photographs is in accord with the view that each fish track represents a quantum of scattered rays (cf. paper by Prof. Hubbard and myself to appear soon in the *Physical Review*). In support of these conclusions, I have received a letter from W. Bothe in which he states (my translation): "I have made precise measurements on the recoil rays [by the Wilson photograph method], and I find that their velocity is in satisfactory accord with your (and Debye's) theory." He writes that the paper describing this work is in the press.

In view of the fact that there was no evidence for the existence of these recoil electrons at the time this theory was presented, their existence and the quantitative agreement with the predictions as to their number and velocity constitute a strong support of the fundamental hypotheses of the quantum theory of scattering.

I am thus wholly unable to agree with Barkla's conclusion that "Compton's formula holds neither for the apparent change of wave-length, nor for the energy of the recoil electrons."

Prof. Barkla, however, emphasises the fact that the

scattered rays obtained when one uses soft primary rays, thin radiators, and thin absorbers are nearly identical in penetrating power with the primary rays producing them. My own spectroscopic and absorption measurements, so far as they go, are in accord with this observation, showing (*Phil. Mag.*, Nov. 1923) that "the effective wave-length change . . . is less for long wave-length X-rays." Here again our differences are chiefly in the interpretation of the experiments.

The experiments of Ross (*Phys. Rev.*, Nov. 1923) and myself (*Phil. Mag.*, Nov. 1923) show that the smaller effective wave-length change observed with the longer wave-lengths does not mean a smaller change for the modified portion of the scattered ray, but rather that a larger fraction of the scattered ray is of the unmodified type. This fact is in accord with the approximate rule which I have suggested, that if the wave-length of the incident ray is greater than the distance between adjacent electrons in the scattering material, a group of electrons will co-operate in their scattering, giving rise to an unmodified line; whereas if the wave-length is less than the distance between adjacent electrons, each quantum will be scattered by a single electron and give rise to a modified ray. On this view, if Barkla using soft X-rays has obtained scattering without change of wave-length, it means that the wave-length of his primary rays is greater than the distance between the adjacent scattering electrons, and hence is scattered by groups of electrons.

The thin radiators and absorbers which Barkla requires to obtain the small change in the character of the secondary rays are from this point of view necessary only because thicker screens would filter out the very soft X-rays of which the wave-length is unmodified. In the published experiments showing this effect (Barkla and Sale, *Phil. Mag.*, Apr. 1923), unfiltered X-rays direct from the X-ray tube have been employed. Under these conditions, rays varying in wave-length continuously from 0·2 or 0·3 to about 1·5 Å are present. To illustrate the effect of this heterogeneity, let us suppose that 80 per cent. of the primary beam consists of the wave-length 0·4 Å, which is changed by the theoretical amount when scattered, but that 20 per cent. is of wave-length 1·2 Å, and is unmodified when scattered. It can then be shown that the effective wave-length of the scattered ray as measured by its absorption coefficient in thin sheets of aluminium is changed by only $\frac{1}{3}$ of the theoretical amount. When, however, matter of appreciable thickness is traversed by the radiation, these great wave-lengths are filtered out, leaving only those wave-lengths for which the modified as well as the unmodified line occurs. Barkla's experiments therefore present no difficulty from the point of view of the quantum theory.

According to Barkla's interpretation of his experiments, the fact that thin screens show effects different from thick ones indicates that the transformation of the X-rays to a softer type does not occur until the scattered rays have traversed layers of matter of appreciable thickness. In the published experiments (Barkla and Sale) thin sheets of paper, of thickness presumably of the order of 0·05 mm., were used to show the effect of scattering by thin films. Barkla himself notes, however, that Wilson's "fish" tracks seem to be associated with the J transformation. But if the transformation occurred after the scattering process, since 0·05 mm. of paper is equivalent to about 5 cm. of air, the fish tracks should appear well outside of the path of the primary rays. The fact that these tracks occur in the path of the primary beam thus indicates that the transformation occurs at the moment of scattering rather than later as Barkla assumes.

Regarding Prof. Barkla's attempt to discredit the evidence obtained from experiments on the scattering and absorption of γ-rays, may I merely point out that the γ-ray experiments decide definitely at least one important question—that the total absorption of very short waves is much less than is permissible on the classical theory? Any transformation of the scattered ray to a softer type, after it has been scattered, cannot put additional energy into the primary beam; and any transformation of the primary beam would only represent an additional method of absorption, leaving a still smaller part of the observed absorption to be accounted for by the classical scattering process. As measured, the absorption coefficient agrees satisfactorily with the formula supplied by my form of the quantum theory, and is unquestionably less than that predicted by Thomson's theory.

In view of the small intensity and the longitudinal asymmetry of the scattered γ-rays, and of the observed change of wave-length of scattered X-rays, I cannot see how Thomson's classical theory of scattering is longer tenable, except as an approximation for great wave-lengths. On the other hand, the experiments described by Barkla, as well as the others which have been considered, receive a satisfactory interpretation on the basis of the quantum theory of scattering.

ARTHUR H. COMPTON.

Ryerson Physical Laboratory,
University of Chicago,
December 16.

An Apparent Connexion between Braxy and Thyroid Activity.

THERE are certain facts in regard to braxy and braxy-like diseases which strongly suggest that the root of the trouble lies in a temporary lessening of the efficiency of the thyroid gland, and a consequent lowering of the resistance of the body to bacterial invasion from the alimentary tract. If this be true, some preparation of thyroid, or even simple iodine, given to the sheep during the autumn and winter months would prevent serious losses amongst the flocks.

Braxy is a disease from which sheep die very quickly during the coldest months of the year. Post-mortem examination shows no sign of disease in some cases; in others it shows bacterial infection of the alimentary canal, and in Scotch braxy sheep bacteria are found associated with a lesion of the fourth stomach; sometimes there is even bacterial infection of the peritoneal fluid. McGowan claims that these are putrefactive bacteria and are not found if the animals suffering from braxy are killed and examined perfectly fresh. He finds other bacteria in the lungs and heart-blood of braxy sheep which have been killed and examined immediately, and claims that these are the specific bacteria of the disease. There is much disagreement amongst the different workers as to the bacterial findings, and there has been keen controversy around the whole subject. One fact emerges, however, and that is that there *is* bacterial invasion of the body from the enteric tract (including lungs) before death, and to a very abnormal degree immediately after death.

The animals are apparently well until a few hours before death, when they become very weak and show symptoms of septicæmia. Usually the best-fed animals succumb to the disease while the less well-fed escape; and the condition is strictly correlated with district, sometimes a flock on one pasture paying a heavy toll to braxy whilst flocks on adjacent pastures escape. Often, too, a change of pasture will put a sudden end to the trouble. There seems to be a sex difference in liability to the disease, for in Scotland at least the hoggs alone are affected. Age

also has a great influence, young animals only being attacked.

In Denmark and in Scotland bacteria have been isolated from the alimentary canal and from the peritoneal fluid, and vaccines have been prepared which, when injected into healthy sheep, reduce the number attacked by the disease and even seem to lessen the severity of the attacks when they do occur. In Scotland a very much older remedy is the "pig dung" treatment. Pigs are fed on a pasture where braxy has been prevalent, and their fæces collected. This is mixed with milk and the strained-off liquid is given to the healthy sheep. This treatment is said to reduce the number of cases of braxy.

Certain known facts in regard to the thyroid gland taken together with the above facts about braxy seem significant. The chief agent in the thyroid's secretion is iodine, and when the demands of the body are being easily met a certain amount of iodine is kept in reserve in a colloidal secretion stored in the vesicles of the gland. When the body makes greater demands this reserve disappears. Now the amount of iodine in reserve in the vesicles, when the demands of the body remain fairly constant, depends entirely on the amount present in the food. Some foods contain more iodine than others, and it is almost certain that different pastures will differ in their iodine content, and therefore some sheep will have more iodine in reserve than others. Be that as it may, one of the chief functions of the thyroid is to prevent auto-intoxication; and for this, those animals which are most richly fed will certainly make greater demands on the gland than those less well fed, and will therefore suffer most from any thyroid- or iodine-insufficiency. It is well known that overfeeding of any kind puts a great strain on the thyroid gland. Along these lines it is easy to account for the loss of the best-fed, as also for the local distribution of the disease, and for the fact that a change of pasture will often put a sudden end to the trouble in any particular flock. Again, it is known that cold makes a great demand on the thyroid, and it is during the coldest weather that braxy is most prevalent, in fact the first outbreak usually occurs with the first "snap of cold." It is also known that the iodine content of the thyroids of sheep and cattle is at its lowest during the first months of the year, and it is during these and the few preceding months that, due to the cold, the greatest demands are being made on the resources of the gland. As was stated above, it is during this period that braxy is most prevalent. It is also universally true amongst animals that the thyroid of the female is larger and is proportionally richer in iodine than that of the males; and again the facts of braxy fall into line, for in Scotland at least, only the hoggs are subject to the disease. Also the thyroid only reaches its fullest activity with sexual maturity and especially with sexual functioning, and again it is the young animals, especially the castrated males, which are attacked by braxy.

It is of especial interest to note the function of the thyroid in controlling the bacterial fauna of the alimentary tract. In cases of endemic goitre there is an excessively large bacterial fauna of the alimentary canal and a corresponding enlargement of the thyroid gland. This enlargement appears to be due to an attempt to meet excessive demands due to the increased number of bacteria, for several different vaccines prepared from *different* isolated bacteria have proved efficacious in reducing the goitre, as also have several intestinal disinfectants. It seems clear that the thyroid has an important function to perform in safeguarding the alimentary tract, and it is known that in cases of extreme thyroid insufficiency bacteria will invade the walls of the alimentary canal and even pass through. An interesting example of this is reported by McCarrison. Pigeons that have been fed exclusively on polished rice show great derangement of the thyroid, ending in atrophy. Such pigeons "die in large numbers from invasion of their blood by micro-organisms . . . which may inhabit their own intestines, and which in health and with a healthy dietary, may exist in this situation as harmless saprophytes." Speaking of deficiencies of certain constituents of the food, he adds, "the effects then . . . are not only failure in the synthesis of the thyroid secretion but a greatly lowered resistance to bacterial invasion."

It is beyond doubt that in cases of braxy in some parts of the world specific bacteria have been found. Some workers have claimed that these specific bacteria are normal inhabitants of healthy sheep. Be that as it may, they are found in unusually large numbers in braxy sheep. If the thyroid, due to shortage of iodine, were unable to meet the extra demands put upon it by excessive feeding and cold, this invasion of bacteria in the walls of the alimentary canal, and even beyond, would be expected. The result would probably be the same whether the bacteria were normally present in small numbers or whether they had been recently taken in with food from infected pastures. Also the fact that vaccines have given good results is to be expected, for they would simply help to keep down a bacterial invasion which under happier thyroid conditions would be prevented naturally. The "pig-dung" treatment also would be expected to give some result, for any bacterial toxin given in small doses causes increased activity of the gland, and thus prepares it to meet increased demands later.

Undoubtedly sheep are on the verge of subthyroidism, for in America very serious losses have resulted from the production of cretin lambs; this difficulty disappeared when iodine was added to the food of the mother sheep.

If, then, the thyroid, which is barely sufficient to meet the normal demands of the body and has not yet reached its fullest efficiency due to sex and age, be overtaxed by season, excessive feeding, and sudden cold, it is not surprising that it should fail in its function of guarding the body from bacterial invasion.

If this be the cause of braxy the slight differences which have been observed in the disease in different parts of the world are easily understood. The bacteria which attack the sheep may not be the same in all parts of the world, and in Australia there may even be no special bacterial invasion, but simple auto-intoxication as was suggested by Prof. Dakin in 1918.

It is realised that the present suggestion is purely theoretical, but in view of the economic importance of the subject it seems advisable to test the effect of the administration of some thyroid preparation or of simple iodine. I am at present carrying out experiments in Wales along these lines. The present year, however, has not been favourable from the point of view of these experiments, for so far the death-rate from braxy has been very low, even among the controls in the flocks with which I am dealing.[1]

RUTH C. BAMBER
(MRS. BISBEE).

The University, Liverpool.

[1] An excellent summary of the facts in regard to thyroid is given by McCarrison, "The Thyroid Gland," 1917. A summary of the facts about braxy is given by: (1) Dakin, W. J., "Beverly Sheep Disease." Report of Biological Dept., University of Western Australia, 1918. (2) Gaiger, S. H., "Investigations into Braxy," Animal Disease Research Association (Scotland), *Journ. of Pathology and Therapeutics*, vol. xxxv. Parts 3 and 4, 1922. (3) McGowan, J. P., "Brachsot or Braxy," *Centralbl. f. Bakt.*, etc., I. Abt. Originale, Bd. 91, Heft 1. Jena. Sept. 1923.

Singlet Series in the Spark Spectrum of Aluminium.

PROF. PASCHEN'S beautiful work on the spark spectra of aluminium has revealed in the case of the singly ionised atom (Al+), a very complete system of triplets (*Annalen der Physik*, 71, 537-561, 1923) analogous to that which appears in the arc spectrum of magnesium. A number of the strongest lines, however, do not find a place in this system, and are obviously members of a system of single lines, like that which exists in the arc spectra of magnesium, calcium, etc.; but he presents no arrangement of these in series.

In the triplet system, the ratios of corresponding terms in Mg and Al+, if plotted against the values of the terms for Mg, give remarkably smooth curves (different for each series), as is illustrated in the Table below:

(THE NUMERATION FOLLOWS BOHR'S SYSTEM.)

	Mg.	Al+.	Ratio.		Mg.	Al+.	Ratio.
$4s$	20475	60589	2·96	$3p_1$	39760	114281	2·88
$5s$	9799	31770	3·24	$4p_1$	13820	46393	3·35
$6s$	5781	19648	3·40	$5p_1$	7419	26141	3·52
$8s$	2709	9681	3·57	$7p_1$	3185	11767	3·70
$3S$	61672	(147107·3)	(2·39)	$3P$	26621	(87262·2)	(3·27)
$4S$	18169	(54485·6)	(3·00)	$4P$	12325	(43758·9)	(3·54)
$3d_1$	13714	56314	4·11	$4f_1$	6995	28440	4·07
$4d_1$	7479	30380	4·06	$5f_1$	4469	18413	4·13
$5d_1$	4704	19041	4·05				
$3D$	15269	(61632·9)	(4·03)	$4F$		(26134·2)	
$4D$	8537	(34201·9)	(4·01)	$5F$		(17164·6)	

Combination.	ν	λ	Intensity.
$3S$-$3p_2$	32700·7	3057·15	10
$3S$-$3P$	59845·1	1670·98	20
$3P$-$3D$	25629·3	3900·68	10[1]
$3P$-$4D$	44568·3	2243·06	4
$3P$-$4S$	32776·6	3050·07	8
$3D$-$4P$	17874·0	6593·23	10
$3D$-$4F$	35498·7	2816·18	20[1]
$3D$-$5F$	44568·3	2243·06	4

[1] These lines show the "normal" Zeeman effect.

It is probable that, as in Mg, Ca, etc., $3S$ is the greatest term, and corresponds to the normal state of the atom, and that the inter-system combination $3S$-$3p_2$ gives a resonance line, strong under moderate excitation. Such a line ought to appear in the arc spectrum of the metal, like the resonance lines of calcium (H and K). The strong line at $\nu = 32700{\cdot}7$, which Paschen doubts whether to attribute to the neutral or ionised atom, appears to meet these conditions. If it is the resonance line, $3S = 147107{\cdot}3$ and the second ionisation potential is 18·17 volts. The ratio to the corresponding term in Mg falls in well with those for the S-terms. If the ratio Al+/Mg is the same for the P and p terms, $3P$ for Al+ should be about 85000, and the principal resonance line $3S$-$3P$ near 62000. There is a very strong line at 59845·1 which is probably the one—in which case $3P = 87262{\cdot}2$ and the ratio Al+/Mg = 3·27—greater by 0·18 than that found by interpolation between the p-terms. The two resonance potentials for Al+, on this interpretation, are 4·04 and 7·39 volts. In the same fashion $3D$ may be estimated to be about 63000, and $3P$-$3D$ to be near 24000. A strong line 25629·3 meets the requirements and leads to the term and ratio given in the Table above. In the same way the line $3D$-$4F$ may be identified (as given at the bottom of the Table). Here we have no corresponding terms in Mg to guide us, but $4F$ comes out somewhat less than $4f$, as in Ca and Sr. The ratio of the $4P$ terms in the two spectra may be anticipated to be about 3·55 (if the p-curve runs parallel to the P-curve), which leads to the identification of $3D$-$4P$, and an exact value of the latter term. Similarly, the ratio for $4S$ should be close to 3·00, and another strong line is found to fit. The identification of $5F$ is doubtful.

All that can be claimed for this arrangement at present is that it accounts for five of the seven lines of intensity 10 or over, which Paschen leaves unidentified, and gives a set of terms the ratios of which to those in Mg run smoothly and reasonably.

Observations in the extreme ultra-violet should reveal the principal series of singlets and clear the matter up. Experiments with an electric furnace should also settle whether λ3057 is the resonance line. This line appears to be present in the solar spectrum. Rowland has an unidentified line of intensity 1 at 3057·257, or 3057·14 I.A., which agrees closely with Paschen's measures. No other lines of Al+ appear, and none should be expected; as on account of the high ionisation and resonance potentials these lines, like 4481 Mg, should appear only in hotter stars.

HENRY NORRIS RUSSELL.

Princeton University Observatory,
December 3.

Problems of Hydrone, etc. Luminous Ice.

IN my recent letter (NATURE, Jan. 26) I refer to Faraday's observation, confirmed by Lenard and Simpson, that a charge can be excited upon drops of water and carried by them *only* if the water be nearly pure. A similar observation was made by Sir James Dewar, that such water became luminous when cooled in liquid air and then exposed to the beam from a naked arc light. In preparing my Memorial Lecture on Sir James, at the Royal Institution, I took opportunity to confirm his observation and gave the demonstration in my lecture on Friday evening, Jan. 18. Two glass tubes were charged, one with good laboratory-distilled-water (not even conductivity water), the other with tap-water, then sealed off. Both were simultaneously cooled in liquid air, then exposed to the beam: when brought out into the dark room, only the tube containing the distilled water was luminous.

The correlation of Faraday's and Dewar's observations is, I think, of such importance that it is desirable to bring the matter under notice. I hope to be able to determine the critical limit of real acidity at least of the luminous phenomenon. Pure water, were it possible, could not be made luminous, I imagine.

In the lecture, I also showed the glow of ozone. Recent observations by Dr. Downey confirm my belief that the glow of phosphorus is that of ozone.

HENRY E. ARMSTRONG.

P.S.—I am stirred by the photograph in Prof. Duffield's letter printed after mine. Is it not a demonstration of the formation of water from molecules of hydrone under the influence of particles of solid electrolyte—maybe of potassium or ammonium salt—carried up in the smoke?

Snow and the Survival of Cod Fry.

IT has been a favourite idea with marine biologists in recent years that a connexion exists between the amount and timely efflorescence of plankton algæ and the success of propagation of certain sea fishes, the fry of which are directly or indirectly dependent upon the plankton algæ for their food. The correctness of this view has been demonstrated at least as regards the mackerel on the south coast of England by Prof. E. J. Allen, who traces the ultimate cause of the algal growth back to more or less abundant

sunshine in the first months of the year. Prof. Gran has also shown that another influence must be at work to produce conditions more or less suitable for the development of plankton algæ, namely, the more or less plentiful amount of fresh water flowing into the sea and carrying with it from the land the salts and other substances necessary for plant life in the sea.

In order to ascertain whether the last-named influence was traceable in the very marked fluctuations occurring in the survival numbers of the different year-classes of the cod population on the western and northern coasts of Norway, total precipitation curves were worked out at our bureau for different parts of the year and for specially selected areas. Part of the result of this investigation is shown in the accompanying diagram (Fig. 1), which represents the aggregate winter (Dec.-March) downfall for three stations in each of six areas (A-F) and half that amount for the six stations in the seventh area (G).

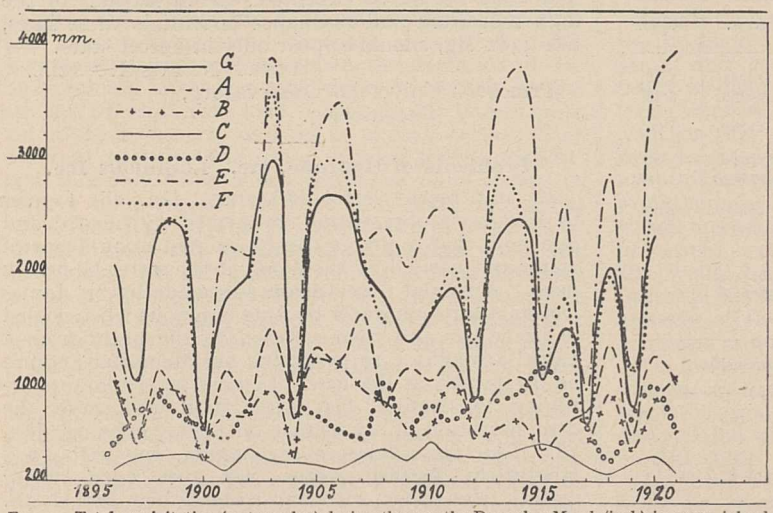

FIG. 1.—Total precipitation (water value) during the months December-March (incl.) in seven inland areas in Norway, 1896–1921. The amounts refer to the sum for 3 stations, except 4 for area G, in which half the sum for 6 stations is given. Areas A and B are in northern Norway, C and D in the eastern, and E, F and G in the western parts.

A includes 3 stations in the mountain regions in northern Norway between latitude 67° and 69°, B 3 stations similarly situated in the Trondhjem district, C is in the eastern and D in the south-eastern part of the country, while E, F and G include sets of stations in the mountain districts of western Norway. It will be seen that the three latter areas especially show very definite minima for the years 1897, 1900, 1904, 1912, 1915, 1917 and 1919.

Now the very interesting coincidence comes to light that so far as our knowledge extends concerning the relative preponderance of the year-classes in our cod population (*i.e.* from 1897 until 1923) it is the very years showing a winter poor in snow which have contributed the richest effective supply of cod fry.

It has been known for several years that the year-class 1904 was especially plentiful alike as regards cod, herring and haddock, and it has been shown later through yearly investigation of scale samples that 1912, 1915, 1917, and 1919 have each yielded a good supply of cod. Examination of some series of scale samples from 1906 point out 1897 and 1900 as years rich in cod fry. This result has been arrived at by yearly observation through extensive measurements and has shown itself in the extraordinary fluctuations of both our "skrei" (spawning cod) and young cod fisheries during the nine years which have elapsed since Prof. Hjort published his study on "The Fluctuations of the Great Fisheries of Northern Europe." The rich year-class 1904 produced good fishing seasons in Finmark from 1908 until 1913 and in the skrei districts from 1912 until 1916; then a very bad period set in culminating in 1918 with the lowest yield of skrei on record, the average size of the fish at the same time reaching a maximum. In 1919 only did a slight increase in numbers set in with the advent of part of the 1912-fish into the ranks of spawners, followed by the good skrei seasons in 1920 and 1921, when this year-class exerted its full influence on the composition of the skrei stock. The richness of the year 1915 has been demonstrated both from its predominance in the Finmark young cod stock since 1920 and from its appearance in the more northern skrei-districts last spring.

The year-classes 1917 and 1919 could so far only be observed in the Finmark stock as the great majority of cod reach maturity only at the age of 8 years, but their preponderance over the year-classes 1916 and 1918 is striking enough. The 1919 fish were eagerly awaited last summer in Finmark on account of the indication afforded by the precipitation records referred to above and we were not disappointed: samples from last year show up to 40 per cent. of four-year-old fish.

In view of the above it is puzzling that the coincidence of a good propagation year for both herring and cod in 1904 did not recur in the later good "cod years" mentioned, the "good years" in the Norwegian herring stock observed by Mr. E. Lea during the latter six or seven seasons being the years 1913 and 1918.

It is not easy at present to say how the coincidence of dry winters and the successful propagation of cod can be explained, but it may be conjectured that the heavy spring-flood consequent upon a snowy winter may cause a big increase of the coastal water driving the fry-carrying bank-water so far out to sea that the cod fry is prevented from gaining a foothold on the bottom sufficiently early in the autumn to ensure the congenial surroundings necessary for its timely development.

OSCAR SUND.

Research Department,
Bureau of Fisheries,
Bergen, Norway, January 3.

The Coccidæ (Scale-insects and Mealy-bugs) of the Madeira Islands.

WHEN recently in Madeira and Porto Santo, I made an effort to collect the species of Coccidæ, and at the same time my friend, Mr. A. C. de Noronha, obtained all he could find, visiting some localities (San Antonio, Ribera d. Sta. Luzia, San Roques) which I had not explored. The result was highly satisfactory, increasing the list from 21 to 46 species. I was fortunate enough to discover five new forms, and one (*Saissetia cerei*) was obtained by Mr. de Noronha. All these have been carefully studied by Mr. E. Ernest Green, who has published the results in the *Bulletin of Entomological Research*, July 1923. The purpose of the present note is to discuss certain aspects of the Coccid fauna, not referred to or not clearly elucidated by Mr. Green, who I think expected me to deal with them.

(1) Of the species described as new from the Madeira Is., only the following can be considered probably endemic: *Phenacoccus latipes* Green, *Pseudo-*

coccus heterospinus Green, *P. artemisiæ* Green (name preoccupied by *P. artemisiæ* Essig, 1909, from California), *Aspidiotus maderensis* Ldgr., *Targionia laurina* Ldgr., *Cryptophyllaspis bornmulleri* Ruebs. No doubt this list of endemics could be considerably increased by careful search. The first and third of the above are from Porto Santo, the third from the small I. de Cima. In Green's list *P. latipes* is said to occur also at Funchal, but there is no mention of this in connexion with the description. *Aspidiotus maderensis* is said to be on *Juniperus cedrus*, which is a Canarian species, not found in Madeira. Presumably it was on *Juniperus maderensis* (*J. oxycedrus* subsp. *maderensis*) of Menezes. I imagine that the ancestors of all the endemic species were brought to the islands as larvæ on the feet of birds.

(2) The remaining 40 species have, I believe, nearly all been introduced by man, Ortheziola being an exception. I had previously visited Madeira in 1879, and had the impression that the Coccidæ in gardens had greatly increased in the interval. This was confirmed by residents, who complained of the plague on cultivated shrubs and trees, and thought that the Argentine ant had a good deal to do with the dissemination of the coccids. An examination of Mr. Green's list shows the prevalence of common tropical species, along with several of those of temperate climates. The climate of the islands is suited to a very wide range of plants, and similarly of coccids. In the garden of Mr. Chas. O. L. Power at Funchal there are growing no less than 56 species of palms, 12 species of tree ferns, 9 of cycads, and great numbers of other trees and shrubs from regions as remote as New Zealand, Fiji Islands, Mexico, Brazil, Japan, South Africa, etc. Thus, were we to try to grow coccids in Madeira, we could probably have a larger collection than in almost any other locality. It naturally results from these conditions that by degrees the islands are stocked with more and more of these pests, brought in on plants, the outcome being very serious to the horticulture of the islands, which are in other respects extraordinarily favourable for horticultural work. The usually small properties in Funchal, with crowded vegetation, make any attempts at eradication by spraying or fumigation extremely difficult. There are also obstacles to the establishment of a satisfactory system of plant quarantine.

(3) The most practicable method of dealing with the coccid invasion is through the importation of the natural enemies of the scales. I found several such enemies already present, but the supply is evidently inadequate. Through Mr. de Noronha, this problem is being attacked by Dr. L. O. Howard and his staff in Washington. Material sent by Mr. de Noronha will show what enemies are actually present, and when sufficient information has accumulated, it may be possible to render important aid. This, however, is a matter for the future, and will be fully dealt with in due season by the Washington entomologists. It may be useful to add that all the localities cited in Mr. Green's list are in the main island of Madeira, except those given as "Porto Santo."

The *Aspidiotus hederæ* in Porto Santo was on native Euphorbia at the base of Pico d'Anna Ferreira.

T. D. A. COCKERELL.

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The Origin of Foot-and-Mouth Disease.

MAY I be allowed to say that I read with much interest the article by Dr. A. Landsborough Thomson, in NATURE of January 12, upon bird-migration in relation to infectivity in connexion with this disease. I noted particularly the writer's statement that mystery still enshrouds the origin of the distinct outbreaks, and also that Dr. Thomson is by no means satisfied that even a prima facie case has been made out for the view that birds carry the virus into Great Britain.

I think, myself, that the question of the real nature of the causative agent in all these "virus-diseases" may be of great importance in its bearing upon their origin. I have recently devoted considerable attention to the question of the nature of "Rickettsia"—bodies, certain types of which are very closely connected with diseases such as typhus-fever and trench-fever, and indeed are to be regarded as, in all likelihood, representing or indicating the virus in these cases. I have formed the conclusion that such bodies are not living organisms, but merely the residual, persistent elements resulting from abnormal blood-digestion, karyolysis in breaking-down cells, and so on (*vide* Journ. Royal Army Medical Corps, February and April 1923, February 1924). The most reasonable inference from this is, I think, that the actual causative agent in the "Rickettsia"-diseases is an abnormal hæmetabolic enzyme or ferment, which induces (primarily) the particular abnormal type of blood-digestion. Similarly with another virus-disease, namely, hydrophobia, where I have found that the characteristic Negri-bodies are nothing more than the result of abnormal alteration of the red corpuscles. I think, therefore, in the case of many virus-diseases, the possibility—to put the matter at its lowest—that the causative agent is an abnormal ferment is one which must be seriously taken into account. We have in the remarkable series of phenomena now known in connexion with the Twort-d'Herelle lytic principle, a most illustrative guide, I consider, to what may be occurring in the virus-diseases.

Now, in my opinion, this view at once opens up an extremely important question bearing upon the incidence and epidemiology of such diseases. If a certain infectious or contagious disease is not due to a micro-organism, there is no longer any absolute necessity to account for the transmission or conveyance of the virus, as has to be done in cases where an organism is concerned (since, of course, a particular organism cannot be created *de novo*, *ad lib.*). On the other hand, given living matter, namely, cells of any kind, we certainly cannot exclude the possibility of some derangement of their metabolism or vital activities occurring, in which a particular pathological "digestive," or lytic enzyme may be developed. That is quite a different thing from the creation of an organism. Therefore, in so far as virus-diseases are due to ferments, we have to reckon, I think, with the distinct possibility that—at any rate, now and again—such a virus can originate and is not necessarily always transmitted from one case of the disease to another.

Applying this view to the instance under consideration, foot-and-mouth disease, I would suggest that the virus may at times originate in the soil or pasture. It may be that, in certain climatic, tillage, or other conditions, this particular enzyme is produced either by some type of living organism with which the soil teems, or by the grasses, etc., of the pasture, either as a result of abnormal metabolism in life or in the process of the break-down and decay of cells. Naturally, of course, it must not be thought that I wish in any way to minimise the grave dangers of infectivity and transmission: but I think the factor to which I have directed attention may also be of importance, in explaining the origin of new and distinct outbreaks of this disease.

H. M. WOODCOCK.

London, January 14.

Liquid Oxygen and its Uses.

By Prof. HENRY BRIGGS, Heriot-Watt College, Edinburgh.

AN article or product regarded as a scientific curiosity by one generation not infrequently becomes a commonplace of the next. The vacuum flask used by Dewar to preserve very cold liquids at normal pressure has become a household necessity for retaining the temperature of warm liquids, and, under modern mass-production methods, the glass flask is now obtainable at a remarkably low price. The metal vacuum vessel, with charcoal in connexion with the vacuous envelope, is less widely known. It is not suitable for the retention of hot liquids; but by reason of its relative robustness and of the large sizes in which it can be made, it is preferable to the glass form for the storage and transport of liquid oxygen or liquid air. Without question, the introduction of the metal vessel has rendered possible such expansion in the commercial and scientific uses of liquid oxygen as is now slowly proceeding. That the importance of the metal vacuum bottle is fully realised, becomes clear upon a perusal of the recently published Report of the Oxygen Research Committee.[1] Quite 90 per cent. of the Report is devoted to the manner of construction of these vessels, to the mode of testing them, to the evacuation of the envelopes, and to certain ancillary but vital problems, particularly those concerned with the behaviour of gas-adsorbents (activated charcoals, colloidal silica, etc.) at liquid-air temperature. Though the general reader may regret the absence from the Report of information respecting both the manufacture of oxygen and the specific uses to which the liquid is put, the Committee has decided wisely in limiting its survey to the aspect of its subject which its members have experimentally studied.

The starting-point of the Committee's labours was a series of memoirs prepared in 1918 by the late Dr. J. A. Harker and his assistants in the Munitions Inventions Department. Harker's nomination to the Committee was most fortunate; armed with a knowledge of physical literature that was probably unequalled in our day, he addressed himself, shortly after the formation of the Committee, to the task of collating the available data concerning the chief low-temperature liquids, and of attempting the quantitative expression of the various sources of heat-ingress to liquid oxygen contained in a metal vacuum vessel. As was to be expected, a few of his tentative conclusions had to be left by the wayside as the research developed; the fact nevertheless remains that Harker erected the scaffolding, dug the foundations, and laid not a few of the lower courses of an edifice which, tragically enough, he was not destined to see in its completed state.

The most important type of metal vacuum bottle is the so-called "container"—a vessel holding about 50 lb. of liquid oxygen, and used for both the storage and transport of the liquid. The manufacture of these containers was a German monopoly before the War, and when, in 1918, they came to be required for the Air and Medical Services, considerable difficulty was encountered in getting satisfactory vessels built in Great Britain. Thanks principally to the persistent labours of the research officers of the Air Ministry, this difficulty has largely been removed, and the British-made container has become equal to the German vessel. At the same time, there is still scope for improvement in these storage flasks, and certain possible lines yet remain to be investigated by the Oxygen Research Committee. There has been a tendency to follow too uncritically the German practice; the Committee has not ascertained, for example, whether the 50-lb. size is the best. When the method of emptying the liquid from the bottle was that of pouring it through the neck, there was much to be said in favour of a vessel that could be lifted and handled by one man; but the introduction of the pressure syphon (and with the advantages of that device the present writer fully concurs) has altered the case, and it would seem not unlikely that a larger vessel is to be preferred. The introduction of bigger containers would decrease the evaporative loss per pound of liquid stored, would reduce the number of vessels required to hold a given supply, and probably would also reduce the ratio of dead-weight to that of the liquid.

It is a drawback of large Committees that they seldom possess the courage of their convictions; though the present Report provides a sufficiency of the necessary data, definite recommendations upon which makers may act are very few. The reader will look in vain for a specification of the 50-lb. container setting forth in plain terms the findings of the Committee as to this vessel, which has received five years of its attention. But it is in the section on the evacuation of metal vessels that the widest breach yawns between the conclusions of the experimental side of the inquiry and the nature of the evacuation plant so completely described and illustrated. The fact is that the latter plant, erected at Kidbrooke by the Air Ministry, was designed a few years ago at a period when data did not exist as to the extent of the reduction of pressure brought about by the activated charcoal connected with the envelope of a Dewar flask, when the charcoal is cooled to liquid oxygen temperature. At the time it was thought to be necessary (and the present writer shared in that belief) to evacuate the envelope to a high degree of tenuity by pumping, and plant consisting of such as the Trimount pump or the Langmuir mercury vapour pump, backed in each case by a rougher pump, generally the Fleuss, was advised. A few plants, like this at Kidbrooke, go even further, and have, sealed to the evacuating system, a bulb containing charcoal. After reducing the pressure by pumping to, say, one-hundredth of a millimetre, the pumps are closed-off, the charcoal bulb immersed in liquid air, and the pressure drawn down to an excessively small amount. Now all this is correct enough practice in evacuating thermionic valves or high-class glass or porcelain vacuum vessels; but the Dewar metal flask possesses its own charcoal, and is thus provided, so to speak, with an internal automatic pump of great potency. The Report makes it abundantly clear (pp. 49-55) how

[1] Department of Scientific and Industrial Research. Report of the Oxygen Research Committee. Pp. vii+177. (London: H.M. Stationery Office, 1923.) 8s. 6d. net.

supremely effectual is the charcoal of the Dewar bottle in reducing the envelope pressure; it shows, for example, that if that pressure were as high as 1 mm., the cooling-down of the charcoal by pouring liquid air into the container would bring about a drop in the pressure to *circa* 0·00002 mm. Hence, for such vessels, "the important conclusion to be drawn is that a really high vacuum pump is not absolutely necessary. A single oil pump, if in good condition, is sufficient."

The Report would have been improved, and a grave inconsistency removed, if the Committee, taking its courage in both hands, had affirmed that the Kidbrooke plant, in spite of certain advantages, represents a stage of development of evacuating apparatus which has now been outgrown. During war a plant of this kind might be required to run continuously, and to depend on a single Fleuss pump would then be a mistake; but if a stand-by pump were required, a second Fleuss pump connected "in parallel" with the first would be preferable to the present arrangement of a Fleuss and a Trimount connected "in series."

It is a relief to turn from this, the weakest section of the Report, to the portion devoted to the operations of testing metal vacuum vessels (p. 91). The writer has experienced the difficulty of "spotting" the very minute leaks which spell the ruin of these flasks, and can appreciate the practical value of the methods which have been evolved by the Air Ministry Oxygen Laboratory.

Perhaps the first attempt to make an industrial use of liquid air was a short-lived trial by Dewar to employ it in driving self-propulsive vehicles. Another early application was that of Linde, who, so long ago as 1897, experimented with the liquid as an agent in blasting. Though Linde's trial was unsuccessful, the idea of preparing an explosive charge by dipping an absorbent cartridge of carbonaceous material into liquid oxygen was taken up by others, and the method was rapidly improved, notably by Claude in France and Kowatsch in Germany. It was found that to be effective the liquid should contain at least 95 per cent. of oxygen. Owing to the shortage of nitrates, Germany, during the War, made great use of liquid oxygen explosives for mines and quarries. The system was introduced at that time into several Lorraine iron mines, and it is significant of its success that the French, after taking over the mines, have not only retained the system but also in some instances are actually amplifying it. Liquid oxygen explosives have certain striking advantages; they obviate, for example, the need for a magazine of explosives near the mine, while in the case of a miss-fire the charge soon becomes innocuous through the evaporation of the liquid. At present, however, there is no known method of rendering them flameless, and their use in the majority of coal-mines is therefore inadmissible. If this drawback could be removed and certain other difficulties relieved, there is a reasonable probability of their use extending.

The earliest self-contained mine rescue apparatus depending for its supply of oxygen upon the evaporation of liquid air carried in the apparatus was that of Suess, an Austrian engineer, whose British patent is dated 1906. It was not successful; nor did that of Claude (1909) meet with a better fate. It was reserved for Col. W. C. Blackett, the well-known English mining engineer and a member of the Oxygen Research Committee, to bring out (1910–11) the first safe liquid air rescue apparatus, the "aerophor." Since then the apparatus has been much improved, and recently three variants of the aerophor have received official approval for use in Great Britain; they have been adopted at nine mine-rescue stations. The charge for the aerophor for at least two hours' effective service is $5\frac{1}{2}$ lb. or more of liquid "air" containing more than 45 per cent. of oxygen; the charge is poured into a non-vacuum vessel containing tightly-packed asbestos-wool and insulated with magnesite-asbestos and leather. The evaporation of the liquid, uncontrolled by any mechanical device, provides the wearer with the oxygen he needs. The apparatus, simple and efficient though it is, could be improved further by using liquid oxygen instead of enriched liquid air. A liquid oxygen rescue apparatus, in which the supply was held in a metal vacuum flask, was proposed in 1921 by E. A. Griffiths. The bottom of the exterior vessel consisted of an aneroid diaphragm; when the diaphragm was flexed inwards, by means of a screw, contact was made across the vacuum space, and an inflow of heat to the liquid of greater or lesser intensity was secured. The rate of evaporation of the oxygen could thus be regulated between sufficient limits.

The airman flying to great heights requires to carry oxygen, and to be provided with mechanical control arrangements to enable him to supply himself with the gas at will. In this connexion a gas-cylinder is objectionable because of its weight, and the lighter liquid oxygen "vaporiser" is preferred. In its usual form the vaporiser is a small metal vacuum vessel fitted with an external boiler, in which is evaporated liquid oxygen syphoned over from the vacuum flask. Originally invented in Germany by Heylandt, and used by the Germans on their long-distance bombing raids, the vaporiser has been improved in detail by the research officers of the Air Ministry, and has become an efficient device capable of giving an accurate and rapid adjustment of supply.

The technical and industrial applications of liquid oxygen are, in peace-time, and under existing conditions, neither numerous nor important. Quite otherwise, however, is the position of gaseous oxygen; its industrial use, especially in America and Germany, has of recent years greatly increased. At least 95 per cent. is used for welding and cutting. A point often overlooked is that, weight for weight, gaseous oxygen can be produced more cheaply than liquid oxygen. With the latter substance the cold as well as the oxygen has to be paid for; in the former, however, the liquefaction process can be made entirely regenerative, and thermal losses (and therefore the power consumption) reduced to a low figure. From the Jefferies-Norton process, now operating on a large scale in America, gaseous oxygen and nitrogen are obtained at roughly the same pressure as they are delivered from the air-compressor (20 atmospheres); all the power needed to run the plant is got by superheating the nitrogen yielded and making it do work in an ordinary steam-engine; when the plant is producing at the rate of 4000 cu. ft. of oxygen per minute the gas costs (it is claimed) only 3*d*. a thousand cubic feet, while when giving 1000 cu. ft. per minute the equivalent price is $7\frac{1}{2}d$.

The advent of cheap oxygen in bulk is bound to bring about revolutionary changes, particularly in metallurgy and gas-making. The boon to these industries in being able to employ what is virtually a nitrogen-free product is sufficiently apparent. Even before the War the use of enriched air for iron smelting attracted attention, and for several years the late Dr. Peters ran a small blast-furnace at Ougrée, Belgium, with slightly oxygenated air obtained by centrifuging atmospheric air on the principle so capably and patiently developed by the veteran engineer, Prof. Mazza, of Turin. The application of oxygen or enriched air to iron making will involve important changes in the chemical reactions involved and in the character of the furnace.

The advantages of oxygen treatment for pulmonary complaints has long been recognised; during the War, and afterwards, a mixture of oxygen and nitrous oxide has proved invaluable in anæsthesia. To render oxygen cheap and plentiful, and to reduce the still grievous weight of the cylinders in which it is carried, would, from the medical point of view, be a great blessing; moreover, in modern warfare it would be of incalculable service to both the military forces and the civil population.

The Transport of Food Substances in the Plant.

IF the stem of a flowering plant is cut across, examination under the microscope reveals the constant presence of three striking tissue systems with their elements extended in a longitudinal direction through the stem, which lie embedded in ground tissue, the cells of which are much less elongated. The outermost of these tissues is composed of fibres in which the walls nearly fill up the cell cavity, and is regarded as strengthening in nature. Within this are two tissues: first, the phloem with elastic walls usually of cellulose, and innermost, the xylem with rigid lignified walls. To these tissues botanists have been practically unanimous in attributing different functions in relation to transport, the xylem being looked upon as carrying the ascending column of water, the phloem as bearing the downward current of manufactured food substances. When, however, Prof. H. H. Dixon, after a preliminary communication to NATURE of February 23, 1922 (vol. 109, p. 236), challenged these long-established views in his presidential address to Section K (Botany) at the British Association meeting at Hull in 1922, it soon became clear upon what a relatively slender experimental basis they rested. The phloem being situated outside the xylem in the stem, it is possible, by cutting a shallow groove, to sever all communication through the phloem whilst leaving the xylem intact. When such ringing experiments are performed, an accumulation of food takes place above the ring, and on the basis of such experiments, largely developed and extended by F. Czapek, who showed that when the phloem was severed in the petiole, for example, starch fails to disappear from the leaf-blade above, the conclusion has been reached that the phloem must be responsible for the downward movement of food substances. Dixon directs attention to Deleano's earlier criticism of these experiments, and certainly, in view of the wider knowledge now available as to the complicated machinery involved in the disappearance of starch from a leaf-blade, many of these experiments cannot now be regarded as convincing, although the accumulation of food substances above a ring upon a leafy stem remains a very significant, well-known fact.

Dixon's main criticism of the view that the phloem is thus functional recalls the "Statical Essays" of the pioneer plant physiologist, Stephen Hales. Considering the carbohydrate present in a potato tuber, and the length of time in which a tuber forms, measuring the cross-section of the phloem in the underground stem leading to the tuber, he estimates the rate at which that carbohydrate must have moved as sugar along the phloem to the tuber. Assuming a sugar solution of 10 per cent. concentration, he finds that its rate of flow would need to have been 50 cm. per hour. Similar calculations, using available data on photo-synthesis in the leaf and measuring the cross-section of the phloem in the petiole, give velocities of the same order for a 10 per cent. solution, figures being obtained of from 20 cm. to 140 cm. per hour. As Dixon points out, no such rate of flow has ever been contemplated by botanists, and the structure of the sieve tubes, the long elements in the phloem with pitted transverse plates, is by no means suited for the transmission of liquid in mass at this rate. It is true that the slimy contents of the sieve tube may contain a much more concentrated solution, Dixon's figure of 2·5 to 5 per cent. concentration in the xylem vessel scarcely being relevant, but such greater concentration would still leave an unexpectedly high rate of flow, for which the phloem seems utterly unfitted. Dixon's alternative explanation is that the bulk of the transport is carried out along the wider vessels of the xylem, in which a more dilute solution may move readily along a channel of greater cross-section.

Dixon marshals experimental evidence for an occasional downward flow in the xylem, from the early experiments of Stephen Hales, in which a tree was inarched into two adjacent trees, its roots being taken out of the ground and its supplies of water drawn entirely from the neighbouring trees. The possibility of such a downward flow will not be doubted; Dixon's difficulty is to show that such a downward flow is of sufficiently regular occurrence in the normal plant to account for the constant return of assimilates from the leaf to the rest of the plant. In this connexion his reminder is timely that earlier experiments have shown how isolated neighbouring tracts of conducting tissue may be within the same stem, so that currents of sap in opposite directions in the xylem of a same shoot are conceivable; they have still, however, to be demonstrated. As a possible driving force for such occasional return currents of sap he directs attention to Thoday's observations upon the changes in volume of a leaf, which may amount to as much as 7 per cent. of the leaf volume in ten minutes. Obviously, however, there is as yet no evidence from the anatomical structure of the leaf to assume that such volume changes should compress liquid into the xylem vessels, and the only observations showing a return drive of sugar solution along the leaf petiole have been obtained by Pitra, in experiments repeated later by Priestley and Armstead, in which the leaves were immersed in water.

Dixon has driven water back along the vascular tracts in the leaf by placing the blade under an external gas-pressure higher than the osmotic pressure in the leaf-cells. Here again, however, without further evidence of the distribution of the pressure gradient, it would seem natural to assume that the water was driven merely out of the living cells, which surround the vascular cylinder in an airtight sheath, not from the cells of the leaf, external to this layer. Dixon also directs attention to the evidence for the movement of hormones in the xylem as witness that organic substances are distributed by their tissue (see NATURE, Dec. 1, 1923, p. 799, "The Nerves of Plants").

On the other hand, quite independently, in America, Mr. Otis F. Curtis, in two papers printed in the *American Journal of Botany* (vol. 7, 1920, and vol. 10, 1923), has been describing experiments which have convinced him that, although carbohydrates may be present in the xylem sap, the xylem is not responsible for their transport. Thus if a healthy shoot is ringed through the phloem, so long as there are leaves above the ring a fair amount of growth is made; but if the leaves above the ring are removed, practically no growth follows, unless even a narrow strip of phloem be left, when growth is very considerable. These experiments seem to prove too much. They were performed with the sugar maple amongst other plants, and in the bleeding season. The conclusion here would seem to be that with plenty of sugar in the sap of the xylem vessels, the sugar must certainly pass above the ring if the young xylem is undamaged, but that sugar alone is not sufficient for growth, and something else is either required to be received (or removed) in small quantity, so that a small strip of phloem suffices for the purpose. Curtis's experiments on the failure of starch to disappear from a region of the stem isolated between two rings through the phloem are, however, very striking, and seem to provide very strong evidence that such carbohydrates are transported by the phloem. In his later paper, by analysis of the shoots above a ring and by observations of symptoms of nitrogen starvation even when the roots are fully supplied with nitrate, he shows that there is considerable evidence that nitrogen and the inorganic constituents found in the ash of plants pass such a ring with difficulty.

The phenomenon of leaf-roll in the potato may ultimately throw light upon this problem. Murphy has shown clearly (Proc. of the Royal Dublin Soc., vol. 17, No. 20, 1923) that the rolling of the leaves is a direct consequence of the excess accumulation of assimilates within them, and it would certainly seem significant that this symptom of the "virus" disease known as leaf-roll is constantly associated with a disorganisation of the phloem. The causal connexion of the two phenomena is, however, still in doubt, Quanjer arguing that the assimilates accumulate on account of the disorganisation of the phloem, Murphy that the phloem disorganises for lack of its proper work, the removal of the assimilates which fail to reach it from the leaf-blade.

Obituary.

MR. W. M. PYBUS.

MR. WILLIAM MARK PYBUS, who died on January 4, was born on April 10, 1851. He was an eminent lawyer in Newcastle-on-Tyne, and he devoted his spare time to natural history, mainly to ornithology. His collection of eggs is well known to ornithologists and is in many respects unique. It numbers about 40,000, and is perhaps the most complete in existence. The many duplicate specimens of the same species were selected with great care to illustrate variation with especial reference to the eggs of the guillemot and the razor-bill, and variations also with regard to locality. In all cases a complete record is given of the time and the place of collection, and the specimens are in a perfect state of preservation. In one case, at least, the collection includes an interesting clutch resulting from a cross between the black cock and the common fowl, and it illustrates the effects grouped under the term "hybrid oology."

Mr. Pybus made many journeys in the nesting season to different places in the northern counties, and later to St. Kilda, the Scilly Isles, the Orkneys and Shetland, and the journeys were usually followed by chatty ornithological papers from his pen. In 1901 he was elected president of the Tyneside Naturalists' Field Club, and his presidential address printed in the Transactions of the Club contained many important ornithological observations. He contributed also an interesting and suggestive paper on the destruction of sand eels by their many enemies, and especially by the heat of the sand between tide marks in summer, from observations made on the Northumberland coast. An account of this work will be found in the Report of the Dove Marine Laboratory for 1912. A. M.

WE regret to announce the death, on January 17, of Mr. Philip Buckle, lecturer in agricultural zoology in the University of Durham. Mr. Buckle was only twenty-seven years of age, and had already published several papers of interest and importance. He was joint author with Mr. Wardle of the recently published work, "The Principles of Insect Control."

WE regret to announce the following deaths:

Prof. E. Emrys-Roberts, professor of pathology and bacteriology in the Welsh National School of Medicine (University of Wales), Cardiff, also known for his antiquarian interests, on January 15, aged forty-five.

Gustaf Eneström, of Stockholm, founder and for eighteen years editor of *Bibliotheca Mathematica* and well known for his work on the history of mathematics, aged seventy-one.

Prof. Marcus Hartog, emeritus professor of zoology at University College, Cork, on January 21.

Sir Archibald Reid, president of the War Office X-Ray Committee, 1914–19, and joint secretary of the Radiology Section of the International Congress of Medicine, on January 15, aged fifty-two.

Prof. S. P. Sadtler, formerly professor of organic and industrial chemistry in the University of Pennsylvania and a past-president of the American Institute of Chemical Engineers, on December 14, aged seventy-six.

Prof. J. M. Stillman, emeritus professor of chemistry at Stanford University, to which institution he was appointed in 1891, on December 13, aged seventy-one.

Prof. R. R. Thompson, professor of oil mining in the University of Birmingham, on January 24, aged thirty-nine.

Current Topics and Events.

ARRANGEMENTS are being made by a committee convened by the Royal Society to celebrate on June 26 the centenary of Lord Kelvin's birth. The committee is composed as follows: Sir Richard Glazebrook (chairman), Prof. F. O. Bower (Royal Society of Edinburgh), Mr. W. R. Cooper (Physical Society), Sir John Dewrance (Institution of Mechanical Engineers), Mr. D. N. Dunlop (hon. secretary), Mr. F. Gill (Institution of Electrical Engineers), Sir Donald MacAlister (Vice-Chancellor of the University of Glasgow), Sir Charles Morgan (Institution of Civil Engineers), The Duke of Northumberland (Institution of Naval Architects), Dr. E. C. Pearce (Vice-Chancellor of the University of Cambridge), Dr. Alexander Russell (Institution of Electrical Engineers), Mr. F. E. Smith (Royal Society). A large number of Dominion, American and foreign men of science and engineers will be attending conferences at the British Empire Exhibition at that time, and July 10 and 11 have been selected as convenient dates for the Kelvin centenary celebrations. These will include a meeting for the receipt of addresses from delegates, at which Sir J. J. Thomson will deliver a memorial oration, and a dinner at which the Rt. Hon. Earl Balfour has promised to preside. There will also be an exhibition of Kelvin apparatus, and probably a memorial volume will be prepared containing the addresses and speeches delivered, with some account of the apparatus exhibited. It is hoped that the president and council of the Royal Society will receive the delegates during the celebrations at the rooms of the society in Burlington House.

THE preliminary programme of the Empire Mining and Metallurgical Congress, to be held at the British Empire Exhibition on June 3-6, has just been issued. The congress is intended to bring together all concerned in the development of the various branches of the mineral industry of the British Empire, and is convened by the Institution of Mining and Metallurgy, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Iron and Steel Institute, the Institute of Metals, the Mining Association of Great Britain, and the National Federation of Iron and Steel Manufacturers. Invitations have been issued to the corresponding Institutions in India, in the British Dominions and Colonies, and have been enthusiastically accepted. The work of the congress will be divided into four sections: mining, subdivided again into coal mining and metalliferous mining; petroleum; metallurgy of iron and steel; and non-ferrous metallurgy; in these the more important problems connected with their various branches of technology will be discussed. It is also proposed to take advantage of this unique opportunity in order to lay the foundation of an Empire Council of Mining and Metallurgical Engineering Institutions, the main object of which would be to create and maintain throughout the British Empire the highest possible standard of scientific and technical efficiency amongst all those engaged in the mining and metallurgical professions. It has long been felt by mining engineers that some means is required by which the public could identify those whose education and experience had qualified them to give trustworthy advice on mining and metallurgical propositions, and it is hoped that an Empire Council will attain this object by establishing a register of qualified mining and metallurgical engineers of the British Empire. Whether this latter part of the programme be carried out or not, it is evidently all to the good of the mineral industries of the great British Empire that representatives of every part thereof should meet in conference with the object of advancing the status of the industries in which they are interested.

IN a paper read before the Illuminating Engineering Society on January 22, Mr. J. S. Dow pointed out the varied opportunities for research in connexion with the applications of artificial light. There are certain outstanding problems such as the selection of an ideal standard of light, series of standard colours and methods of colour-nomenclature, and the definition of "white light," which require much time for solution. The same applies to many questions involving co-operation between the physicist and the physiologist, *e.g.* the effects of light of different colours on the eye and the phenomena classed as "glare." Other questions, such as the conditions of lighting necessary in various industries, cannot be dealt with properly by individuals, but need the efforts of joint committees, on which both the lighting expert and the user should be represented. Considerable progress has been made in instruments for the measurement of illumination, but the use of a battery and glow-lamp is a drawback to the average user; in future possibly the problem may be solved by the use of photo-electric cells in some form of physical photometer, calibrated in the laboratory but relieving the eye of the observer from the task of making a photometric balance. Hitherto attention has been devoted mainly to intensity of light. But our methods of controlling the colour of light emitted are progressing, and the various effects and applications of special forms of radiation form a fascinating field for study. In conclusion the author pleaded not for undue organisation, but co-ordination of research—a condition specially desirable in connexion with the subject of lighting, with which so many different experts are concerned.

IN the course of his introductory address at a meeting of the Royal Microscopical Society (Industrial Applications Section) on January 23, the chairman, Sir Robert Hadfield, discussed the use of the microscope in metallurgy, and its application to the study of the structure of metals. Special reference was made to the effects produced on the physical properties of various kinds of steel by what may be termed "cold treatment." If manganese steel (with which Sir Robert's name is so intimately associated) be stressed so as to cause deformation, some change of structure, probably a change of crystallisation, is

produced without any chemical action or heat treatment. As a result of this change a remarkable alteration occurs in the physical properties, the ball hardness of the metal rising from 200 Brinell ball number to about 600. Such a change in physical structure is not obtained in mild steel, carbon steel or other alloy steels when similarly treated; nor does it occur in these or in manganese steel when subjected to the stresses which must occur when the metals are brought to the lowest temperature obtainable, or put under extremely high hydrostatic pressure. In the study of such changes, which are not indicated in any way by chemical examination, the microscope has proved of the utmost service. In referring to high power photomicrography of opaque metallurgical specimens, Sir Robert disputed the idea that photomicrographs of higher magnification than 1500 are of little or no value, and directed attention to those taken in his own laboratory at a magnification of 8000, and more recent photomicrographs obtained at a magnification of 9000 by an American worker, F. F. Lucas, who has shown that good definition, resolution and penetration can be obtained at those high powers.

ON January 23, Mr. W. B. Hardy formally declared open a laboratory for research in colloid chemistry and physics which has been founded in the University of Manchester by the generosity of a number of Lancashire firms. This laboratory, which has been named after Thomas Graham, the founder of the science of colloids, consists of two large and three small rooms, and is being specially equipped for the proposed course of research. It has been put in the charge of Mr. D. C. Henry, of Trinity College, Cambridge, who has been for two years a lecturer in chemistry at the University of Manchester. Mr. Hardy's available time was unfortunately much curtailed by the disorganised train service, but he reviewed the life and work of Thomas Graham, pointing out that in his time, as in that of William Harvey two centuries earlier, there was no royal road to scientific research work; in the absence of scholarships, fellowships and grants, nothing short of a passion for knowledge would lead a man along the arduous path of research. Colloid chemistry was defined by Mr. Hardy as essentially a kinetic science, dealing with the slimes, amorphous jellies and non-crystallising precipitates which classic chemistry throws down the sink; "it faces, as no other science does, the material facts of existence, and for that reason it is of tremendous service to the biologist and to the industrialist." The laboratory was thrown open for inspection after the conclusion of Mr. Hardy's address.

PROF. C. G. BARKLA will deliver the seventh Silvanus Thompson Memorial Lecture of the Röntgen Society at the Institution of Electrical Engineers on Tuesday, April 1.

THE Marquess of Salisbury has consented to accept the office of president of the thirty-fifth Congress of the Royal Sanitary Institute, to be held at Liverpool on July 14-19.

THE annual dinner and reunion of the Institution of Electrical Engineers will be held at the Hotel Cecil, Strand, W.C., on Thursday, February 21, at 7 P.M., under the presidency of Dr. Alexander Russell, supported by the Council.

THE Council of the Yorkshire Philosophical Society, York, has recently elected as honorary members of the Society Mr. Charles E. Keyser, president of the British Archæological Association, Prof. Percy F. Kendall of Leeds, and Mr. Arthur H. Smith, keeper of the Greek and Roman Antiquities in the British Museum, London.

THE sixth of the public lectures on "Physics in Industry" arranged by the Institute of Physics will be delivered on Wednesday, February 6, at 5.30 P.M., by Prof. C. H. Desch, who will take as his subject "The Physicist in Metallurgy." The lecture will be delivered in the rooms of the Chemical Society at Burlington House, Piccadilly, W.1.

THE forthcoming British Industries Fair, organised by the Department of Overseas Trade, Old Queen Street, Westminster, S.W.1, will be held at the White City, London, on April 28-May 9, and at the Castle Bromwich Aerodrome, Birmingham, on May 12-23. As in previous years, heavy products, such as engineering appliances and building materials, will be shown at the Fair to be held in Birmingham, the lighter commodities being displayed at the White City.

THE *Times* correspondent at Copenhagen announces that the International Education Board founded by Mr. John D. Rockefeller a year ago has made a grant of 8000*l.* to Prof. Niels Bohr for the development and equipment of his laboratory. The report refers to Prof. Bohr as having "lately discovered the new element 'hafnium,'" but this, of course, is incorrect. The discovery was made by Dr. D. Coster and Prof. G. Hevesy, though the actual work was done in Prof. Bohr's laboratory.

IN connexion with the forthcoming expedition of the *Discovery* for research into whaling and other scientific work, applications are invited for the posts of surgeon, zoologists, and of a person qualified in chemistry and physics. Forms of application are obtainable upon written application to the Secretary, *Discovery* Committee, Colonial Office, Downing Street, S.W.1. The forms should be returned by February 14, except in the case of candidates abroad, to whom an extension may be allowed.

ACCORDING to the Berlin correspondent of the *Times*, a violent explosion occurred on January 24 at the Leuna Works, a large chemical manufacturing concern near Merseburg, in Saxony. The works, which were producing synthetic ammonia and nitrate during the War, had been engaged on the preparation of artificial manures, and it is stated that the explosion took place in the department where ammonia products were manufactured, a high-pressure container having blown up. At least six men appear to have been killed and a number severely injured.

THE gold medal of the Royal Astronomical Society has been awarded by the council to Prof. A. S. Eddington, for his work on star-streaming, on the

internal constitution of a star, and on generalised relativity. In accordance with a decision of the council, the gold medal will in future be presented, not at the annual meeting, but at a later meeting. This will be in general in June. At the annual meeting this year, to be held on Friday, February 8, Sir Frank Dyson, Prof. Turner, and Mr. Evershed will speak on the progress of astronomy, and the president, Dr. J. L. E. Dreyer, will give a short address on the desirability of a new edition of Isaac Newton's works. After the annual general meeting Mr. F. W. Aston will give a short address on isotopes.

ON December 26, 1898, Pierre Curie, Madame Curie, and M. Bémont announced to the Academy of Sciences of Paris the discovery of radium, and in the issue of *La Nature* for January 19, M. Vigneron gives an account of the steps taken to celebrate in a fitting way the twenty-fifth anniversary of the event. Under the presidency of M. Poincaré, a meeting was held in the grand hall of the Sorbonne, and addresses were given by Profs. Perrin and Lorentz, M. Debierne and Dr. Réclère, with demonstrations of some of the principal properties of radium. The addresses constitute a complete history of radioactivity and an abstract is given by M. Vigneron.

ON Thursday and Friday, January 10 and 11, the seventh joint meeting of the Challenger Society and representatives of Marine Biological Stations was held in London under the chairmanship of Mr. W. B. Hardy and Prof. E. W. MacBride. The meeting was attended by about fifty representatives of various institutions, etc. Papers were read by Messrs. H. A. Baylis, W. T. Calman, F. M. Davis, E. Ford, H. W. Harvey, J. R. Lumby, H. G. Maurice, A. Meek, N. Mackintosh, and A. D. Ritchie; and specimens were exhibited by Messrs. H. A. Baylis and C. Tate Regan. Special attention was paid to recent investigations of the bottom fauna of the North Sea and Plymouth areas, and to the hydrography of the North Sea and the English Channel. An exhibition of sounding and other deep-sea instruments, some of which were loaned by the Telegraph Construction and Maintenance Co., was arranged at the Science Museum.

THE National Physical Laboratory, Teddington, undertakes the official testing of watches, and the highest number of marks awarded up to December 1923 has been given to a Solvil watch made by M. Paul Ditisheim, of La Chaux de Fonde, Switzerland. This watch, which gained 97 marks out of a possible total of 100, is a plain lever going barrel two-day "deck watch" of robust construction. It is considered that on account of variations in humidity and atmospheric pressure, and also in the recording instruments and the observers themselves, no watch could in practice gain more than 98·5 marks. The achievement of 97 per cent. is therefore noteworthy. In 1902 the highest figure attained was 92·7 marks. In 1903, M. Ditisheim was awarded 94·9 marks, and by successive stages the number of marks were increased until, in 1919, 96·9 was reached. With the new record, M. Ditisheim has thus for twenty-one years secured the highest number of marks among more than 18,000 watches tested in the National Physical Laboratory trials.

THE first medical congress to be held in Australasia under the sole auspices of the British Medical Association met in Melbourne last November, and an account of the meeting is appearing in the *British Medical Journal*. The president was Mr. G. A. Syme, and the opportunity was taken to open the new anatomy department of the University of Melbourne, the ceremony being performed by Sir William Macewen, and to unveil the war memorial dedicated to the memory of the forty-three members of the Victorian Branch of the British Medical Association who lost their lives in the War. Many papers of scientific value were contributed, and the president in his address dealt in particular with the public health of the Commonwealth. It was announced that the Federal Committee of the British Medical Association had instituted a medal to be given for meritorious service to the Association, the profession, and the community, and the first two awards were made to Dr. W. T. Hayward and Dr. R. H. Todd.

AN international conference on applied mechanics is to be held on April 22-26 at Delft, Holland. Work will be divided among three sections: (1) mechanics, (2) theory of elasticity, and (3) hydro- and aerodynamics (including aeronautics). Two days of the meeting will be occupied by general sessions and two by sectional meetings for the reception of original communications. The following are among the subjects to be considered at the general sessions: stress problems, theory of rupture, friction and lubrication, fluid motion, turbulence and the dynamics of the atmosphere. The executive committee organising the conference consists of Profs. C. B. Biezeno, J. M. Burgers, and J. A. Schouten (Delft), and Dr. E. B. Wolff (Amsterdam), and among those who have signified their approval of such a conference are Profs. J. S. Ames, L. Bairstow, V. Bjerknes, E. G. Coker, P. Forchheimer, T. Levi-Civita, L. Prandtl, and G. I. Taylor. Those intending to participate in the meeting should communicate with Prof. J. M. Burgers, Delft, Nieuwe Laan 76, before February 15.

PROF. HARRY N. HOLMES, chairman of the Committee on Colloids of the United States National Research Council, informs us that the papers and discussions presented at the first annual Colloid Symposium, held at Madison, Wisconsin, in June 1923, have been published by the Department of Chemistry of the University of Wisconsin. Copies may be obtained at the cost of publication (2.75 dollars per copy, including postage), from the University Co-operative Company of Madison, Wisconsin.

A MEMORIAL publication to commemorate the centenary of the birth of Mendel, entitled "Studia Mendeliana ad centesimum diem natalem Gregorii Mendelii a grata patria celebrandum adiuvante ministerio Pragensi edita," is in preparation. The editorial part of the book is in Latin, the scientific treatises in the languages of the respective authors.

Scientific workers of all nationalities have contributed to the volume; the British contributors are Dr. W. Bateson and Prof. R. C. Punnett. The firm of "Typos," Brno, Czecho-Slovaquia, Rennergasse 22, is producing the volume.

THE fifth Report on Colloid Chemistry drawn up by a Committee of the British Association has been issued through H.M. Stationery Office by the Department of Scientific and Industrial Research at a price of 2*s*. 6*d*. It contains six papers: on surface tension, by Dr. A. Ferguson; on collagen and gelatin, by Prof. Procter and Mr. J. A. Wilson; on colloid phenomena in bacteriology, by Dr. E. K. Rideal; on wetting power, by Mr. W. H. Nuttall; on ink, by Mr. C. Mitchell; and on artificial silk, by Mr. E. Wheeler. It also contains an index to the five Reports which have now been issued. The fifth Report appears to mark the completion of this series of reports, since it is stated to be "the last of the series."

UNDER the title of "A Romance of the Rostrum," Messrs. H. F. and G. Witherby will shortly publish by subscription a limited edition of a history of Stevens's well-known auction rooms and particulars of some of the sales there during the past hundred years. The volume has been compiled by E. G. Allingham, Lord Rothschild contributes a preface, and Mr. Henry Stevens personal reminiscences.

Our Astronomical Column.

ANOTHER EINSTEIN ECLIPSE RESULT.—Mr. G. F. Dodwell, of Adelaide Observatory, observed the total eclipse of September 1922 at Cordillo Downs in Central Australia. The station was difficult of access, the last 400 miles being traversed on camels across desert country. Yet Mr. Dodwell made two expeditions there, the second being some months after the eclipse, to obtain check plates of the stars after the sun had moved away. The photographic apparatus consisted of a doublet lens lent by Prof. Curtis; its scale was scarcely adequate for the problem, but the conditions of transport precluded very heavy instruments.

A check field was selected a few degrees distant from the eclipsed sun; an exposure was made on each plate on both the eclipse field and the check one; the same procedure was followed on the control plates taken some months later. It is thus possible to eliminate errors due to distortion of the field by the lens, and indeed all errors that can be presumed to follow the same laws on both occasions. The plates were measured at Greenwich by Mr. C. R. Davidson, who announced the results at the Royal Astronomical Society on January 11. The separate results for the different plates had a wide range for the shift at the sun's limb; the extremes were 0·7″ and 2·4″. The mean of all is 1·77″, practically Einstein's value, but the probable error is 0·5″. The result, taken alone, would scarcely be decisive as between the Einstein shift and the half shift, but it adds further weight to the values obtained by the Lick Observatory and the Canadian expedition.

THE COMPANION OF MIRA CETI.—It appears from Pubns. Ast. Soc. Pacific (Dec. 1923) that Dr. A. H. Joy suggested to Prof. Aitken on October 6 the search for this companion. He had noticed a sideways displacement of the peculiar spectrum of bright hydrogen and helium lines which comes up at minimum. He suspected that this might arise from a close companion star in P.A. 135°. October 19 was the first day on which seeing conditions permitted an examination with the 36-inch telescope. The companion proved to be an easy object, 0·90″ distant in P.A. 130·3°, and ¾ mag. fainter than Mira, which was then at minimum (mag. 9·2). "According to Joy, the companion has a spectrum of early type with excessively strong Hβ and Hγ and fairly strong λ 4471 and H and K of calcium." The companion is photographically brighter than Mira at minimum, which explains the almost total disappearance of the M-type spectrum at that time. Its discovery also necessitates the rediscussion of Mira's light curve. It must be half a magnitude fainter at minimum than was heretofore thought, as the joint light of the pair has been measured.

It is noted that the companion has presumably the same proper motion as Mira, since the latter is moving 0·23″ per annum towards P.A. 186°, so otherwise the distance 10 years ago would have been more than 3″. It remains a mystery why the companion was not seen during the many occasions in recent years when Mira was examined by Burnham, Barnard, Doolittle, and many others. It may be itself variable, but its spectral type does not make this likely.

Van Maanen found a negative parallax for Mira: it is suggested that distortion of the image by the presence of the companion may explain this. It will be seen that the discovery raises many interesting questions, and may be said to open a new chapter in our knowledge of this "wonderful" star.

OCCULTATION OF A STAR BY JUPITER.—Very useful predictions of occultations of stars by planets are made by Mr. L. J. Comrie.

That of B.D. − 14°·4045 on May 7 last was observed at Johannesburg by H. E. Wood and W. M. Worsell (Union Observ. Circ. No. 58). The observations support the presence of an extensive cloud-laden atmosphere in Jupiter. Both disappearance and reappearance were gradual, and accompanied by well-marked fluctuations of light; at the last glimpse at disappearance and the first at reappearance the star appeared "embedded" in Jupiter's disc.

The disappearance was at a point in the South Tropical Belt, the reappearance just outside the Belt to the north. Mr. Worsell estimated both phases earlier than Mr. Wood, by 8 seconds at disappearance, and 14 seconds at reappearance. Jupiter was moving 0·3″ per minute.

AN INTERESTING ALGOL VARIABLE.—The naked-eye star in Lynx, Boss 1607, R.A. 6^h 20^m, N.Decl. 56° 20′, normal magnitude 5·75, was found by Adams in 1911 to be a spectroscopic binary showing only one spectrum. An article by K. F. Bottlinger and P. Guthnick (*Astr. Nach.* 5263) describes researches made on it with the photo-electric cell at the Babelsberg Observatory, Berlin, beginning February 6, 1923 (on which date a principal minimum occurred). They find that it is an eclipsing variable, the period being 9·944 days, according to the spectroscopic results; an addition of 0·0004 days to the period is suggested by a Potsdam observation of November 5, 1899, when the star was abnormally faint, and presumably near principal minimum. This minimum lasts at most 0·9 day and the loss of light is at least 0·36 magnitude. The secondary minimum has not yet been certainly detected; the loss of light is estimated to be at most 0·02 magnitude, so that there is great disparity in brightness. Further observations are necessary before the elements of light-variation can be accurately determined. Dr. Joel Stebbins had already directed attention to the hopeful field which spectroscopic binaries offer to students of light-variation.

Research Items.

EXCAVATIONS AT TEL-EL-OBEID.—Remarkable discoveries made by the joint expedition of the British Museum and the University Museum of Philadelphia at Tel-el-Obeid, a site about four and a half miles from Ur, are described by Mr. C. L. Woolley, in the *Times* of January 19. A tablet has been found which records the foundation of a building discovered by Dr. Hall in 1919 beneath the remains of two later buildings—one a temple, dating probably from the Second Dynasty of Ur; the other a temple erected by Dungi, second king of the Third Dynasty (*c.* 2250 B.C.). From this tablet it appears that this building, which was entirely buried beneath the mud-brick terraced floor of the Second Dynasty temple, was the temple of the goddess Nin-Khursag, set up by King A-an-ni-pad-da of the First Dynasty of Ur. It is therefore the oldest dated document yet known, and, further, it confirms the existence of a dynasty hitherto regarded as mythical. In the list of kings of Sumer and Akkad drawn up soon after 2000 B.C., it is given as the third from the Flood, and dead reckoning would place it at about 4600 B.C., though Sumerian history, properly speaking, could not be carried beyond 3000 B.C. A remarkable feature of this temple is the lavish use of copper for decorative purposes in the form of friezes, reliefs, and statues of cattle, wall-facings, and sheathings of palm-logs and roof-beams. Yet flint was still in common use and copper was both costly and scarce.

PETRA.—In a communication presented to the Royal Geographical Society on January 14, Sir Alexander Kennedy gave an account of the ruins of Petra based partly on personal observation and partly on a survey from the air. While the attention of those who have visited Petra has been attracted to the Roman remains, it is rather the remains of the Nabatæans and their possible predecessors which are likely to prove fruitful in results. Sir Alexander Kennedy classifies the monuments in these divisions according to the probable source of their more obvious architectural features. Of these, the oldest is the "Assyrian," distinguished by "crow-step" gables, or rather half gables, which may correspond to the horns of an altar. The second type is the "Egyptian," with the hollow quadrantal type of cornice which is associated invariably with two gigantic half-steps, taking the place of the line of small crow-steps. About one-fifth of these have plain fronts and simple doorways, about one-third have a pilaster supporting the cornice, and nearly one half of the whole have an attic with a frieze. These two classes are both Nabatæan and form the majority of the 514 tombs, store-houses, dwellings, etc., with which the suggested classification deals. Of the remainder, about twenty-four belong to the classical division, and doubtless date from a time after the Roman conquest in A.D. 106.

EXCAVATIONS AT KISH.—In a letter to the *Times* of January 22, Prof. Langdon, writing from Mesopotamia, gives an account of the results to date of this season's excavations at Kish. Among an amount of pearl and limestone inlaid work discovered in a mound constructed entirely of plano-convex bricks, characteristic of the oldest Sumerian architecture, was a rectangular tablet of slate which shows a king of Kish smiting his Sumerian enemies. Their closely shaven heads, cheeks, and upper lips, but long beards, indicate a date earlier than Ur-Lagash, *c.* 3100 B.C. Taken with other pearl heads found here, this disposes of the theory that the Semites occupied Kish in the prehistoric period. The discovery north of Inghara of two large Sumerian buildings in a state of complete preservation has made possible the preparation of the only known plan of a large Sumerian palace. Below the plano-convex brick pavement, which cannot be later than 3100 B.C., was an accumulated deposit of 15 feet representing at least 1500 to 2000 years previous occupation, and therefore going back to about 5000 B.C. A complete sequence of pottery from the earliest Sumerian period down to Nebuchadnezzar has been established, and a series of fine copper implements has been found. The general result of the excavations brings into prominence the enormous extent of the ruins, which, if grouped contiguously, would cover 120 acres, the very great antiquity of the site, and the priority of the Sumerians.

PHYSIOLOGY OF AMŒBOID MOVEMENT.—From observation of marine Amœbæ of the limax type, Mr. C. F. A. Pantin, in Journ. Mar. Biol. Assoc., vol. xiii. p. 24, 1923, concludes that this organism can be looked upon as a contracting tube of gelated ectoplasm closed at the posterior end; the anterior end is occupied by the fluid ectoplasm of the advancing pseudopodium. The fluid endoplasm streams forward through this tube from a place of liquefaction within the posterior end of the Amœba. On reaching the anterior end, the streaming endoplasm apparently forms the fluid ectoplasm of the advancing pseudopodium. This fluid ectoplasm adds continuously to the contracting tube by gelation at the sides of the pseudopodium. Mr. Pantin brings forward evidence in favour of the view that the swelling and liquefaction of the anterior ectoplasm is due to the liberation of an acid, and that on removal of the acid the imbibed water is lost and the ectoplasm contracts. This contraction helps to push the pseudopodium forward. Although this conclusion cannot be regarded as proved, yet it indicates that amœboid movement may have a fundamental similarity to muscular contraction and ciliary movement. It is interesting, in this respect, to note that, so far as Mr. Pantin has investigated the relationship of amœboid movement to the properties of the surrounding medium, he has found it to be parallel to that of other forms of contraction. In acid media Amœbæ cease to move at about P_H5, but the loss of movement is entirely removed on raising the alkalinity of the medium. Experiments with water of varying osmotic pressure show that movement is only possible when the water content of the cell lies within certain limits. Singularly little is known at present of the physiological changes accompanying amœboid movement, but further experiments on the above lines seem likely to afford interesting and valuable results.

GRAFT-INHERITANCE.—A brief account is given by M. Lucien Daniel (*Comptes rendus* of the Paris Academy of Sciences, p. 1449) of experiments in which he grafted the artichoke (*Helianthus tuberosus*) on the sunflower (*H. annuus*) and obtained numerous small aerial tubers. The plant set seed, and the seeds when sown yielded fourteen plants which differed from each other in vigour, precocity, foliage, and root system. They produced tubers which varied in form, colour, and weight, some plants producing many aerial and few subterranean tubers, others the reverse. The results show that new varieties may result from grafting. This is claimed as a case of the inheritance of a character acquired by grafting, and it is difficult to see how this interpretation can be denied. In any case the work is of very much interest, and will no doubt be continued to another generation.

INHERITANCE OF EMBRYONIC CHARACTERS.—It is pointed out by Prof. T. H. Morgan in an article in the *Scientific Monthly* for January that many embryonic characters are now known to be hereditary and to follow Mendel's law in crosses. The most extensive evidence has been derived from the caterpillar of the silkworm, especially by the work of the Japanese investigators Toyama and Tanaka. The many races of silkworms differ chiefly in the colour of the larvæ and the colour and shape of their cocoons. A number of these have been shown to be Mendelian differences, some of them sex-linked. Among other insects such differences are found in the nun, the gypsy moth, the clover butterfly, the potato beetle, the meal-worm and the banana-fly. The down-colour of chicks is another character of immaturity which Mendelises in various breeds of poultry.

INTESTINAL FLAGELLATES OF TERMITES.—An interesting study of the correlation between the food of termites and the presence of protozoa in their intestines has been carried out by L. R. Cleveland (*Amer. Journ. Hygiene*, vol. iii. pp. 444-461). Workers of practically all the species of termites in the U.S. National Museum have been examined for intestinal flagellates and the results are recorded. All species of the Mastotermitidæ, Kalotermitidæ, and Rhinotermitidæ which were examined contained protozoa and wood in their intestines. Wood and protozoa were also found in the intestines of three species of the Termitidæ. The correlation between a strict wood-feeding habit and the presence of intestinal protozoa is perfect and positive. The author states that in a later paper it will be shown that the protozoa are symbionts and that termites without protozoa cannot live on a strict wood diet.

NORTH AMERICAN BLOOD-FLUKES.—Horace W. Stunkard (Bull. Amer. Mus. Nat. Hist., vol. xlviii. pp. 165-221) prefaces his studies on North American blood-flukes by a brief description of the three families —the Schistosomatidæ of birds and mammals, the Spirorchidæ of turtles, and the Aporocotylidæ of fishes, and their genera. The genus Spirorchis contains several species and produces a widely distributed infection in many species of North American fresh-water turtles. The adult flukes live in the heart and arteries, especially the pulmonary, carotid, and mesenteric arteries, and in some districts 90 per cent. of the turtles are infected, there being from four to eight flukes in each turtle. The eggs are deposited in the blood-vessels and become distributed throughout the body of the host. They rupture the capillaries, pass into the tissue, and abound in the lungs, liver, spleen, kidneys, mesentery, and in the wall of the intestine. The majority of the eggs ultimately reach the alimentary canal or one of its evaginations, whence they pass to the exterior. If kept for some weeks in water, a miracidium develops and hatches, but the subsequent life-history is unknown. The author regards the three families of blood-flukes as constituting a well-defined monophyletic group, and looks upon the Schistosomatidæ, the only diœcious trematodes, as derived from the Spirorchidæ. He suggests that the location of the schistosomes in the portal and mesenteric veins has been the factor responsible for the development of the diœcious condition.

SEASONAL CHANGES IN PLANTS.—Prof. F. J. Lewis and Miss Gwynethe M. Tuttle have an interesting note (*New Phytologist*, volume 22, pages 225-232, December 1923) on the effect of the change from winter to summer upon the contents of the living cells in *Picea canadensis*. With the advent of summer, starch reappears in these cells, the chloroplasts are reorganised, and the pigment alters in character; but a striking result of the further work of these authors is to show that these changes appear to commence in early April in Canada, quite independently of the surrounding temperature, and occur in darkness to the same extent as in light. Conifer leaves from 6500 feet in the Rocky Mountains seem to undergo these changes at approximately the same date as leaves in the Edmonton district at 2240 feet.

GROUND-WATER HYDROLOGY.—Investigations into ground-water hydrology have been actively pursued in the United States in recent years, as illustrated by the long series of water-supply papers published by the Geological Survey. Paper No. 492 presents a short outline of ground-water hydrology, the main object of which is to define and explain the terms in use. Geologists and geographers will be grateful to Dr. O. E. Meinzer for producing this pamphlet, since there is great need of defining and making precise many of the terms which are in vogue in hydrology. He proposes to use the term " subsurface " in place of " underground " for all water below the surface, while " ground water " or " phreatic water " is used to designate the water in the zone of saturation, in contrast to " suspended " or " vadose " water in the zone of aeration or that overlying zone in which the rocks are not saturated. The origin and various usages of all the terms are discussed. The paper is well arranged and illustrated and deserves close attention.

EXTREMELY DRY LIQUIDS.—Prof. G. N. Lewis has published in the December number of the Journal of the American Chemical Society an explanation of the anomalous properties of exceedingly dry liquids, such as have been studied by Baker. He considers a hypothetical liquid consisting solely of simple molecules A and complex molecules of a single molecular species, B, assuming that the equilibrium $A \rightleftharpoons B$ is immediately established in the presence of moisture. The vapour of such a liquid would probably consist of A molecules only. When the last traces of moisture have been removed the equilibrium $A \rightleftharpoons B$ will be fixed, and if the temperature is kept constant the vapour pressure will remain constant, as well as the proportions of A and B in the liquid. If the liquid is now heated, more of the A molecules will escape and finally only B molecules will remain, these not escaping until the boiling point is reached, or until the rate of formation of A from B, in the absence of the catalyst, is appreciable, because of the temperature increase. Baker has found that this is the case for dry benzene, which can be fractionally distilled. It seems, therefore, that water acts as a catalyst for processes between various molecular states. Lewis makes some interesting inferences from this theory; *e.g.* that liquids of abnormally low boiling points should exist, besides those with abnormally high ones.

SHRINKAGE OF PHOTOGRAPHIC FILM.—Mr. F. E. Ross has recently communicated to the Royal Photographic Society (Journ. Roy. Phot. Soc., January) the results of his investigation on the " Mensurational Characteristics of Photographic Film," especially from the point of view of its use by astronomers. The work was carried out in the Research Laboratory of the Eastman Kodak Company at Rochester, N.Y. The samples were 4 inches square, had fine reference marks near each corner, and were measured at various stages by means of a Hilger comparator. The contraction on development (after drying) was about 2 to 6 parts in 10,000, but changes as great as 0·2 per cent. occurred within a few days, and as much as 0·5 per cent. in passing from winter to summer. During four years the contraction varied from about 0·2 to 0·4 per cent. The undeveloped film changes

similarly according to the season and atmospheric humidity. Mr. Ross has investigated the relation of width to length contraction, the influence of the support, the effect of humidity, and the effect of drying by means of alcohol, which is so great as to render its use prohibitive. He has also measured the shrinkage over large areas, the distortion within small areas, and secular shrinkage. To obviate these changes so far as possible, it seems better to keep the film in a loose condition (not in tight rolls) in a well-ventilated chamber, and to subject it for a few days before measurement to a slightly higher humidity than existed at the time of exposure.

PERSIAN CRUDE OIL.—Dr. A. E. Dunstan gave an account of the crude oil production of Maidan-i-Naftun district, Persia, to the Institution of Petroleum Technologists in January, and apart from the technical details involved, it was gratifying to learn that production from this oilfield has been steadily on the increase since 1912, 2,913,908 tons of petroleum having been won during the year ended March 1923. The oil is obtained from the Asmari Limestone, capped by the better-known Lower Fars series (which includes the gypsiferous beds) of Miocene age. It is a mobile brownish green oil of average specific gravity 0·837, and is remarkably free from water; it is of mixed base, though with paraffin tendencies. The commercial products of refining include naphtha, from which refined benzine and kerosene are prepared, and residual fuel-oil yielding on further treatment gas-oil, heavy oil and wax, and pitch-residue. From the heavy oil fraction some good lubricating oil and paraffin wax are derived. Large quantities of natural gas occur in association with the oil, the gas being noteworthy in the high percentage of sulphur (10 per cent. hydrogen sulphide by volume) it contains. It is thus difficult to handle the gas commercially, though certain desulphurising processes have proved satisfactory. It is now proposed to extract and utilise this sulphur, strip the gas of its gasoline and use the residual gas for field-power. Another interesting point is the high percentage of vanadium and nickel, two extremely active catalytic agents, found in the ash; the former shows as much as 5·03, the latter 2·70, per cent.; in addition there is an appreciable quantity of manganese oxide. The ash also exhibits a small degree of radio-activity.

PNEUMATIC GRAIN ELEVATORS.—The opening part of a discussion on pneumatic grain elevators appears in the *Engineer* for January 11. The authors—Prof. W. Cramp and A. Priestley—were assisted by the Department of Scientific and Industrial Research, and completed the research some four years ago, although it was not advisable or possible then to publish the results. A paper embodying some of the work was published in 1921 by the Royal Society of Arts, and it is now possible to amplify and complete that paper by publishing the rest of the results obtained, and by suggesting a rational basis for future design. This basis leads to considerable modifications in the accepted proportions, and in so far as these changes have been at present adopted by manufacturers they have fully confirmed the experiments, which were carried out at the University of Manchester and have led to considerable economies, both in pipes and in power. The work requires extension by similar tests upon horizontal and inclined pipes and by further work upon nozzles. The present articles are of importance inasmuch as the manufacturers of these plants seem purposely to have avoided the publication of technical data, and to have looked upon test results and calculations as esoteric, consequently the literature on the subject is almost worthless. The investigation of the flow of a mixture of air and grain in a pipe is a very complicated problem.

EARTHQUAKE BUILDINGS.—Some novel proposals for minimising the damage to buildings subject to earthquake shocks are discussed in *Engineering* for January 11 by Mr. W. H. Thorpe. The author suggests that the fundamental idea ought to be the supporting of the building in such a manner that it does not of necessity move as the earth moves. So far as horizontal movements are concerned, this may be secured by suspending the building by tension rods from stable steel frames, or, in the case of light structures, from flexible steel uprights, or, as has recently been proposed by Prof. Bailey Willis of Stanford University, U.S.A., by supporting the structure upon balls of cast-iron, steel, or granite. Mr. Thorpe quotes figures for an office building 160 ft. by 80 ft. by 60 ft. high, to be carried by a steel platform suspended at twelve points. The total weight would be about 5400 tons, and the suspension rods would be about 20 ft. long and attached to the top of wide-based towers, generally, though not of necessity, housed within the building. The towers would be well founded, and these would be the only part of the structure required to move with the earth movement. The author considers that the increase in cost would be about 20 per cent. over that of an ordinary building. No suggestions are made for countering the effects of vertical earth movements.

ELECTRIC PASSENGER LIFTS. — The paper on electric passenger lifts, read by Mr. Marryat to the Institution of Electrical Engineers on January 18, is a very timely one. Except in a few very special cases, electric lifts are more economical and convenient than hydraulic lifts. Very little has been written about them, however, probably because it is a combination product of the builder, the electrician, and the engineer. In modern buildings a really efficient lift service serving both the incoming and outgoing traffic is of far more importance than the staircase. In several cases the function of the latter is merely to act as an emergency fire escape. In London offices the records show that the "rush" hour is from 12 to 1, and that 30 seconds represents the limit of the patience of the average City man when waiting for a lift. Elaborate tests were made to find the limits of acceleration and deceleration possible. It was found that the unpleasant physical sensations experienced by the passengers were due mainly to any sharp change of acceleration, the result of imperfect control. By a careful correction and smoothing of the acceleration curve, it was found possible to accelerate to a maximum speed of 600 feet per minute in 48 inches without discomfort to the passengers. The average speed of the lifts of the London Electric Railways is only 180 feet per minute. There is a tendency to increase this speed to meet the desire of the travelling public for faster travel; but, as the author pointed out, express lifts, however well run, compare unfavourably with an escalator service at tube stations, the depths of which are 60 feet or more. By taking films it was discovered that the value of the acceleration oscillates rapidly when the lift is in motion, but no reason can be definitely assigned for this. There is no lift running at more than 400 feet per minute in Great Britain. The author advocates lifts for speeds of 600 feet per minute. This is quite feasible. The tendency to work shorter hours and at higher speed has produced a demand for a rapid lift service to replace stairs.

Toronto Meeting of the British Association.

THE preliminary programme of the annual meeting of the British Association in 1924, to be held in Toronto, Ontario, on August 6-13, under the presidency of Sir David Bruce, has just been issued. This will be the second occasion on which the Association has visited Toronto, the first being in 1897, under the presidency of Sir John Evans, the second of the three meetings previously held in Canada (Montreal, 1884; Toronto, 1897; Winnipeg, 1909). Active measures are being taken, both in Toronto and at home, with the object of ensuring that the meeting shall afford an exceptional opportunity for intercourse between British, Canadian, American, and European workers in science, and, to visiting members, an unique occasion for acquainting themselves with the manifold scientific interests of the Dominion. The University of Toronto, which ranks with its affiliated colleges as one of the largest in the British Empire, will be the principal centre of the meeting.

The Association will meet in thirteen sections as follows, the names of the president and recorder of each being given, together with the address of the latter. A (Mathematics and Physics): Sir William Bragg; Prof. A. O. Rankine, Imperial College of Science and Technology, London, S.W.7; B (Chemistry): Sir Robert Robertson; Prof. C. H. Desch, University, Sheffield; C (Geology): Prof. W. W. Watts; Prof. W. T. Gordon, King's College, Strand, London, W.C.2; D (Zoology): Prof. G. Elliot Smith; Prof. R. D. Laurie, University College, Aberystwyth; E (Geography): Prof. J. W. Gregory; Dr. R. N. Rudmose Brown, University, Sheffield; F (Economic Science and Statistics): Sir William Ashley; Prof. H. M. Hallsworth, Armstrong College, Newcastle-upon-Tyne; G (Engineering): Prof. G. W. O. Howe; Prof. F. C. Lea, 36 Mayfield Road, Moseley, Birmingham; H (Anthropology): Dr. F. C. Shrubsall; Mr. E. N. Fallaize, Vinchelez, Chase Court Gardens, Enfield, Middlesex; I (Physiology): Dr. H. H. Dale; Prof. C. Lovatt Evans, Physiological Laboratory, St. Bartholomew's Medical College, London, E.C.1; J (Psychology): Prof. W. McDougall; Dr. Ll. Wynn Jones, 7 St. Mary's Avenue, Harrogate; K (Botany): Prof. V. H. Blackman; Mr. F. T. Brooks, 31 Tenison Avenue, Cambridge; L (Educational Science): Principal Ernest Barker; Mr. D. Berridge, 1 College Grounds, Malvern; M (Agriculture): Sir John Russell; Mr. C. G. T. Morison, School of Rural Economy, Oxford.

The inaugural general meeting will be held on Wednesday, August 6, in the Convocation Hall of the University of Toronto, when Sir David Bruce will deliver his presidential address. In the sections, addresses will be delivered by the respective sectional presidents, and papers will be read, on and after Thursday, August 7, until the conclusion of the meeting (Wednesday, August 13).

Joint meetings of various sections will also be held, at which the following are among the subjects expected to be discussed: A and B—Crystal structure, and colloid solutions; A and G—Optical study of elasticity; B, I, and M—Vitamins; B and C—Liquid fuels; C and E—Changes of sea-level in relation to gravitation, continental shelves, and coral islands; D and K—Species concept; D and M—Soil population; F and M—Diminishing returns in agriculture; H and J—Racial mental differences; I and J—Physiological and psychological factors of muscular efficiency in industry; J and L—Mental and educational tests in scholarship examinations.

For those in Great Britain desirous of attending the meeting, some useful information is afforded in the programme. The main routes to Toronto are from Southampton, Liverpool, or Glasgow, either direct to the Canadian ports of Quebec or Montreal, or to New York or another United States port. The lines to Canadian ports have the advantage of an open sea voyage of only four to five days, the remaining three to four days of transit being on the land-locked waters of the Gulf of St. Lawrence, and on the St. Lawrence River. The journey to Toronto by this route occupies nine to ten days. By taking one of the fastest steamers to New York, Toronto may be reached in about seven days.

The cost of passages varies according to route and vessel; the following average *minimum* figures for the single voyage are given: By largest vessels on New York service, 57*l*.-59*l*. (First class) to 17*l*. (Third class); by smaller vessels on New York service, and by vessels to Canadian ports, 39*l*.-50*l*. (First class) to 16*l*. (Third class). In round figures, the cost of the journey from a British port to Toronto and back, by "cabin" ship or second class, may be put at 60*l*. (excluding incidentals). The third-class accommodation on many of these ships, having cabins (two or more berths) and saloons, is also stated to be very good; the open "steerage" of former days having disappeared. If it should be found that any considerable number of members desire to travel by this class at any particular date, the companies have offered to make, so far as possible, special arrangements for their comfort. The return fare from a British port to Toronto, third class on steamer, may be put at approximately 36*l*. (excluding incidentals). The shipping companies have offered to provide members with superior accommodation at minimum fares, so far as it is possible to do so. Convenient sailings range from July 23 to 29. Members are warned that, unless they are citizens of the United States, they must obtain the United States consular *visa* on their passports not less than a fortnight before leaving Great Britain. British subjects proceeding to Canada and returning to the British Isles require passports to secure re-entry.

As regards accommodation in Toronto, particulars are given of various hotels, and in addition the University of Toronto men's and women's residences, Burwash Hall, Annesley Hall (women), Wycliffe College, and Knox College will be available for upwards of 600 persons (single rooms), for which the charge will probably be 1 dollar per day, and it is expected that the University dining-halls will be available for meals at tariff rates.

A preliminary programme of excursions after the meeting is also being arranged. For those able to devote the maximum time, an excursion across Canada to Vancouver, and possibly also to Prince Rupert and Victoria, is contemplated. This excursion offers an excellent opportunity of seeing the physical features of the country and its natural resources. Those who are able to take advantage of it will be able to see something of the farming, fisheries, mining, timber, pulpwood for paper-making, and water-power in Quebec and Ontario; the nickel, silver, and gold regions of Northern Ontario; the prairie and ranching country of the West, including the Great Wheat Belt; the Alberta and British Columbia coal regions; and the timber, pulpwood, and fruit-growing country of British Columbia, and the famous fisheries of its coast. The route crosses the Rocky Mountains and passes close to the Red Deer Valley in Alberta.

Each of the two Canadian railway systems has granted the Association the exceptionally low rate

of 1½ cents a mile to overseas visitors for the trans-continental excursion, exclusive of sleeping berths. The exact route has not yet been decided, but an approximate estimate of the expenses is 17*l.* for fare and 15*l.* for berths, and the total cost of the excursion will be, approximately, 50*l.*

The officers of the local committee dealing with arrangements in Toronto are as follows: Chairman of general and executive committees: Prof. J. C. McLennan; local hon. secretaries: Prof. J. C. Fields, University, Toronto, and Prof. J. J. R. MacLeod, University, Toronto; assistant local secretary: Major J. M. Mood; local hon. treasurer: Dr. F. A. Mouré, University of Toronto.

Delegates of Corresponding Societies will meet, by invitation of the Museums Association, during the meeting organised by that Association at the British Empire Exhibition, Wembley, on July 21-26. At the British Association meeting, there will be a conference of local scientific societies.

The Tarnishing and Fogging of Metals.

By Prof. H. C. H. CARPENTER, F.R.S.

SOME years ago, as a result of the action taken by certain members of the Royal Institute of British Architects, a Committee was set up composed of representatives of that Institute, the Institute of Metals, and the British Non-Ferrous Metals Research Association, charged with the duty of making arrangements for the experimental investigation of the causes of the atmospheric corrosion of non-ferrous metals. The necessary funds were provided by the Department of Scientific and Industrial Research, the British Non-Ferrous Metals Research Association, and various interested persons. Mr. W. H. J. Vernon was appointed to carry out the experimental work, and the report of his first investigation was presented and discussed at the Faraday Society on December 17 last.

The research has been initiated and developed mainly along two lines: (1) Tests carried out with relatively large specimens exposed to representative atmospheres in order to compare their effects on typical metals and alloys, and to correlate the behaviour of as wide a range of materials as possible; and (2) laboratory experiments conducted on relatively small specimens with the object of obtaining insight into the mechanism of tarnishing and corrosion. The present report deals mainly with tarnishing, filming, and fogging, which represent the early stages of corrosion. Four types of atmosphere were investigated: (1) An indoor atmosphere maintained continuously in the unsaturated condition with respect to water vapour; (2) an indoor atmosphere of variable but relatively high humidity, occasionally reaching saturation; (3) an ordinary domestic kitchen; and (4) open-air exposure on the roof of the Royal School of Mines building at South Kensington. The specimens have been examined visually and with the aid of a microscope, accurate determinations have been made of the increase in weight of the test-pieces from time to time; but probably the method which has given the most information has been an optical one, in which, after suitable preparation, the reflectivities of the surfaces have been determined, both in the freshly cleaned condition and during the course of exposure. Mr. Vernon has found that the loss of reflectivity affords a very sensitive means of estimating the changes taking place at the surface, more particularly in the earliest stages of tarnishing. His method consisted in comparing the light from two similar lamps in a Lummer Brodhun photometer, one of the lamps being so arranged that its light could be either (1) allowed to fall directly upon the photometer, or (2) reflected on to it from the metal surface under examination, the total length of the beam being the same in each case. The use of a suitable colour screen placed over the eye-piece of the photometer was necessary.

Three types of curves, the co-ordinates of which are weight-increment and time, have been obtained and their significance discussed in relation to the function of the tarnishing product or scale obtained. In the first case, the curve is a parabola the axis of which coincides with the time axis of the co-ordinates. Weight-increment is thus proportional to the square root of the time; that is, the rate of attack is retarded as the period of exposure increases. The scale forms a continuous envelope and subsequent tarnishing can only take place by diffusion of the corroding atmosphere through it. From the point of view of the solution of the problems envisaged by the Committee this is the most favourable case. Copper within a wide range of humidity variations falls within this class. In the second case, the curve is a straight line passing through the origin, and weight-increment is directly proportional to the time. Here the scale is completely permeable and allows free access of the atmosphere to the metal. A typical example is furnished by zinc in an unsaturated atmosphere. In the third case, the curve is a parabola the axis of which coincides with the weight axis. Weight-increment is proportional to the square of the time; that is, the rate of attack is accelerated as the period of exposure increases. The scale is not merely permeable but discontinuous. The metal iron in an atmosphere of relatively high humidity corrodes in this way. The influence of the condition of the surface has been carefully examined, and, as a rule, the rougher it is the greater the tendency to tarnish.

At least two, if not three, types of attack have been found to take place. There is, first of all, what Mr. Vernon terms "tarnishing," in which characteristic colour changes are brought about by the presence of *gaseous* sulphur compounds. Liquid water is not necessary, for the action takes place at temperatures considerably above the dew-point and increases as the temperature is raised. Excess of water vapour reduces the rate of tarnishing. The presence of either solid or liquid particles appears to be without appreciable influence. The metal copper furnishes a variety of instances of tarnishing according to the condition of the atmosphere.

Another variety of attack is the "smoky" film, developed in an unsaturated polluted atmosphere on the high zinc brasses. Microscopical examination shows that in the early stages the action predominates on the α (copper rich) constituent, while subsequently within the areas occupied by the "smoky" film the attack is largely concentrated upon the β (zinc rich) constituent. This attack appears to be due to the presence of solid or liquid particles, probably sulphuric acid. A third type of attack is illustrated by the behaviour of nickel in an indoor atmosphere at temperatures near to the dew-point, when a characteristic filming or fogging of the surface occurs. This film may readily be removed in the early stages but becomes more persistent as the duration of exposure increases. The same phenomenon is shown by nickel-copper alloys. In such cases a humid atmosphere produces "fog" and an unsaturated atmosphere gives rise to tarnish.

It is to be hoped that Mr. Vernon will develop his research on the lines of investigating the phenomena of tarnishing, filming, and fogging with the view of finding out exactly what they really are. They undoubtedly represent the early stages of corrosion, and if they can be prevented from taking place, atmospheric corrosion will seldom, if ever, occur. Their elucidation will require strictly controlled laboratory experiments where the effect of each variable can be determined.

Scientific Societies in Poland.

THE following short account of some of the scientific societies recently organised or reorganised in Poland will be of interest to scientific workers.

The Polish Chemical Society, established in 1919, has at the present time five local branch sections (Warsaw, Cracow, Lwow, Poznan, Lodz) and 539 members. Its chief publication is the *Roczniki Chemii* (Annals of Chemistry), appearing in yearly volumes of about 600 pages each. The address of the Society's Office is: High Technical College (Politechnika), 75 Koszykowa, Warsaw. In 1919 a National Chemical Council was founded, consisting of representatives of pure and applied chemistry, under the presidency *ex officio* of the State Minister of Commerce and Industry. This advisory body directs the policy of the State in matters respecting chemical industry in time of peace and war.

The Polish Mathematical Society, founded in Cracow in 1919 and reorganised in 1920, under the presidency of Prof. W. Staniewicz, has two local sections (Cracow, Lwow), and publishes proceedings under the title: Annales de la Société Mathématique Polonaise.

The Polish Radiotechnical Association, founded in Warsaw in 1922, has affiliated branch sections in Poznan, Torun, Lwow; the president is Commander Jackowski.

The Polytechnic Society of Warsaw, initiated in 1918, reorganised in 1921, publishes Proceedings at regular intervals; the president is Prof. H. Czopowski, of the Warsaw High Technical College.

The Polish Botanical Society edits (i.) Acta Societatis Botanicorum Poloniæ, (ii.) Przeglad Botaniczny (abstracts of current botanical literature). The Society is under the presidency of Prof. B. Hryniewiecki (6/8 Aleja Ujazdowska, Warsaw).

The Polish Ethnological Society, originated in 1921 in Warsaw, under the leadership of Prof. Jan Czekanowski; it publishes the quarterly review *Lud* and the collection entitled *Wisla*. The Wisla series is a continuation of a valuable collection published by the late Prof. Majewski (20 volumes). The last volume of *Wisla* is devoted to Dr. Ciszewski's elaborate paper "Common Salt."

The Copernicus Association of Polish Naturalists, founded in 1874 in Lwow, was reconstituted in 1918. Its chief publication is the monthly periodical *Kosmos*; forty-six yearly volumes have already appeared. The papers printed in *Kosmos* are written in Polish, with substantial résumés in French, English, or German. The collection of geological papers contained in the *Kosmos* series is of exceptional value and importance for the geology of Poland. The total membership of the Association is 451. To promote the diffusion of natural knowledge in Poland, the Association publishes a separate monthly magazine of popular character. A limnological station was established in 1911, under the auspices of the Association, in Drozdowice, in the neighbourhood of Grodek Jagiellonski; destroyed by the Russian Army in 1915, the station was re-erected in 1920. Another limnological station exists in Plociczno, about 10 km. from Suwalki; this station, which owes its foundation to the Scientific Society of Warsaw, has now been at work for about three years, under the direction of Dr. Litynski.

In addition, there are the Cracow Academy of Sciences and the Polish Physical Society, references to the activities of which were made in NATURE of July 28, p. 140, and August 4, p. 173.

In 1920, fifteen Polish scientific societies existing in Lwow appointed a Joint Scientific Board with a view of co-ordinating and unifying their efforts. This organisation includes now, under the leadership of the Scientific Society of Lwow, twenty-six societies and institutions existing in Lwow and the Philological Society of Przemysl.

Poland is doing well to encourage by all the means in its power the growth of scientific organisations which tend to provide the highest kind of instruction and to disseminate knowledge.

Soil Sourness.

THE meeting of the Section of Botany of the British Association at Liverpool concluded with a discussion upon "The Effect of Soil Sourness on Plants," in which the various theories put forward to account for this condition were debated.

The discussion was opened by Mr. A. G. Tansley, who emphasised the extreme complexity of the problem, and the need for ecologists to analyse carefully the soil factor. Having briefly mentioned the chief types of plant communities found on acid soils in Britain, he considered the relation of xerophilous structure to soil sourness, pointing out that Schimper's theory of "physiological dryness" was an inadequate explanation of the correlation. The influence of the hydrogen-ion concentration of the soil upon the distribution was then considered. It was pointed out that the effect of sourness might not be directly due to the hydrogen-ion concentration, but to various causes, such as the presence of soluble toxic salts, the ratios of certain soil bases one to the other, etc.

Dr. E. J. Salisbury emphasised the fact that the incidence of wild species in relation to hydrogen-ion concentration could be presented as a variation curve with a principle mode (*e.g.* P_H 5·5 for *Pteridium aquilinum*, P_H 7·2 for *Psamma arenaria*, etc.). The range for a given species is often considerable, depending upon other factors of the environment, of which competition and water content were specially cited. For most species the incidence curve exhibits a second mode which is very marked for those the primary mode of which is near the neutral point (*e.g. Mercurialis perennis, Ficaria verna*, etc.). The correspondence of this bimodal curve with that for growth in culture solutions of varying hydrogen-ion concentration but constant ratio of bases was emphasised. The incidence curves represented the summation of both direct and indirect effects of acidity, but demonstrated the importance of this habitat factor. It was pointed out that the effects of acidity were manifested beyond the point at which toxic iron and aluminium salts are precipitated. It

was also emphasised that the ratio of bases is not a constant for a given soil but varies with the water content, especially with respect to potassium. Moreover, the ratio on which bases are absorbed would appear to be itself dependent on the hydrogen-ion concentration. Experiments in which the proportion of potassium was increased had shown an increase of lime-loving species.

Dr. N. M. Comber considered chiefly the "sourness" of certain agricultural soils and their characteristics. The cause of "sourness" could not be the hydrogen-ion concentration, since this is sometimes high when "sourness," as measured by the character of the crop, is absent. Nor was it merely the ratio of calcium to other metals (*e.g.* potassium and sodium), since the addition of neutral calcium does not decrease the sourness, and the addition of potassium salts does not enhance it. He indicated the evidence that the ratio of *basic* lime to weak bases (chiefly alumina) was a fundamental cause of sourness.

Dr. W. H. Pearsall simplified the problem by considering the growth and distribution of aquatic organisms such as green algæ and diatoms, and pointed out that the former or latter predominated according as to whether the ratio $\frac{K+Na}{Ca}$ was high or low. He gave details of water culture experiments in which Eriophorum and Sphagnum both grew rapidly with high basic ratios (in the absence of alumina) whether the P_H was 4·5 or 7. He stated that heath plants have a high fat concentration which is chiefly affected by the basic ratio.

Prof. J. H. Priestley indicated that the relative proportion of certain bases in the soil materially affected the migration of fatty substances along the cell walls. As a consequence the deposition of fat might be considerably modified by the bases in the soils. Plants forming unusually large quantities of fatty acids, such as those characteristic of peaty habitats, might be disorganised when grown on soils containing more calcium, as the result of the choking of the tissue immediately behind the meristem through the accumulation of calcium soaps. From this point of view the important "basic ratio" in the soil was the proportion of K+Na+Mg to Ca.

Prof. D. R. Hoagland, of California, referred to the importance of studying the actual soil solution, means for which had now been devised, and emphasised the fact that the results so far obtained indicated a varying basic ratio with changing water content. All common agricultural plants had been grown in water cultures at a P_H of 4·8 although plants have great power of reducing the hydroxyl-ion concentration.

Dr. W. R. G. Atkins disagreed with Dr. Salisbury about the two optimum P_H values for the distribution of certain plants, and suggested that exceptions in the distribution of desmids and diatoms might indicate the existence of other controlling factors than that of basic ratios.

Dr. Joseph, of Khartoum, spoke of the highly alkaline soils of Egypt, and stressed the point that no mention of the importance of the physical condition of the soil had been made during the discussion.

Dr. M. C. Rayner said that in *Calluna vulgaris* the hydrogen-ion concentration was not a critical factor since it could be grown in a solution of P_H 8.

Dr. H. Jeffreys emphasised the need for detailed field observation of plant distribution, and the importance of the competition factor.

Dr. Salisbury briefly replied to some of the issues which had been raised.

Annual Meeting of the Association of Women Science Teachers.

THE annual meeting of the Association of Women Science Teachers was held on Saturday, January 26, at University College, London. At the business meeting a resolution was passed unanimously, in the following terms:

"The A.W.S.T. feels that the need for a course of training for intending teachers of science is very great, and fully realises that the problems and difficulties confronting them are different from those obtaining in other subjects. The Association therefore suggests that to meet the need it is important that greater facilities for practical work, and more specialised training in the organising and manipulative side of science teaching, should be given in many of the Secondary Training Colleges."

It was stated that very few science teachers have been trained, and this is in part due to the fact that very little special consideration is given to their work at the Training Colleges, and that therefore the course is of less use to them than to Arts students.

It seems to be the experience of most senior science mistresses in Secondary Schools that the junior mistresses who come to them straight from the Universities have no experience of the type of experiment with which they have to cope in school, and that therefore their whole attention has to be given to the manipulative work, and none is left for the class. This is obviously an undesirable state of affairs, and it was urged that science students at Training Colleges should have considerable practice in the actual performance of experiments, and to a less extent in the improvising of apparatus, either in the laboratories of the Training Colleges, or, where such do not exist, in a good Secondary School. In the latter case the practice should be continuous for some weeks, in order to give the student an idea of laboratory management, and the planning out of the contents of a syllabus.

Mr. C. A. Carus-Wilson then delivered an address on a new method of approaching the general elementary science which normally precedes the more specialised study of physics and chemistry. The main points of his contention are (1) that the present method is too academic for junior classes, and tends to be very limited in scope; (2) that by considering the properties of well-known substances the child is given something which can be linked on to his everyday life. The study of the properties of different materials, such as hardness, toughness, elasticity, the relative heaviness (without accurate weighing), the relative fusibility of metals, the changes in property induced by heat, would give a very good general idea of heat and mechanics on which formal physics and chemistry could later be built. If, on the other hand, the child does not proceed any further than the general course, he will have a far more intelligent idea of the world about him than is given by the usual study of relative densities, thermometers, etc.

In the afternoon, Dr. G. L. Elles gave a lecture on "The Scientific Interpretation of Scenery." She said that the science of geomorphology recognises that two factors are at work in the evolution of scenery—one constructive and resulting in the building up of mountains, the other destructive and tending to reduce everything eventually to a uniform level. The former includes volcanic action and other internal factors of change in the earth's surface. The destructive forces of denudation include weathering and transport of the broken-down material. Erosion is of different types according as it is carried on by water, ice, or dry sand driven by the wind.

University and Educational Intelligence.

ABERDEEN.—The University Court has appointed Dr. William Blackadder to be professor of engineering. Dr. Blackadder is lecturer in the department of mechanics, Royal Technical College, Glasgow. This is the first appointment to the recently founded Jackson chair of engineering in the University.

CAMBRIDGE.—The Board of Trustees of the Rockefeller Foundation in connexion with its Division of Medical Education has made a munificent offer to help in the development of the School of Pathology in the University. The sum of 100,000*l.* is offered for building a new School and for its general maintenance, and 33,000*l.* towards the endowment, provided that the University can secure the remaining 33,000*l.* necessary to complete the endowment. The Trustees express pleasure that they "are to have some small share in aiding in the complete development of the provisions for cultivation of the medical sciences at Cambridge." The Council of the University has under consideration the steps necessary to enable the University to accept this offer of the Rockefeller Trustees. It is greatly to be hoped that the necessary money will be secured without too long delay.

Once again Mr. and Mrs. Molteno have shown keen interest in and willingness to support the Institute for Research in Parasitology, which they founded and endowed at Cambridge. They have made a further contribution of 500*l.* to the funds of the Institute to cover deficits on the building account and current expenditure.

The lectures on the history of medicine are being continued this term by Sir Clifford Allbutt on "Medicine in Rome" and "Byzantine Medicine," and by Prof. E. G. Browne on "Arabian Medicine." Sir J. G. Frazer will lecture in Trinity College on "The Belief in Immortality and the Worship of the Dead in Micronesia."

The Gordon Wigan prize for research in chemistry has been awarded to R. G. W. Norrish, Emmanuel College, for an investigation on "The Kinetics of Heterogeneous Reacting Systems."

With reference to a memorial freely signed by members of the Senate and forwarded to the Council of the Senate asking that the election of members of the Council and voting on important Graces should be by ballot, the Council recommends the appointment of a Syndicate. The names of those proposed as members of the Syndicate are the Vice-Chancellor, the Master of Sidney Sussex College, Dr. Buckland, Dr. Keynes, Dr. Sorley, Dr. Clapham, Mr. W. W. R. Ball, Sir Horace Darwin, Mr. F. J. M. Stratton, Mr. J. R. M. Butler, and Mr. G. G. Morris.

The Clarence Graff fellowship for an unmarried graduate of Oxford or Cambridge is announced. The fellowship is of 250*l.*, together with tuition, and is tenable for one year at a University in the American Middle West. The candidate is to be genuinely interested in international problems, and expecting to enter on a career where he may have influence over a large and varied public. Preference will be given to a candidate whose interests are humanitarian rather than commercial or narrowly scientific.

Applications for the George Henry Lewes studentship (the annual value of which is about 230*l.*) should be sent by March 1 to Prof. Langley, at the Physiology School, together with particulars of the qualifications of the candidates, the subject of their proposed research, and the name of a referee.

LEEDS.—The collection of British mosses and hepatics made by the late Mr. W. Ingham is to be given to the University, and a number of models illustrating the history of road construction and specimens of materials used in the construction of roads and streets has been presented to the Engineering Department by Mr. E. W. Cockerlyne.

The following appointments have been made: Mr. W. J. Will, to be assistant lecturer in agriculture; and Mr. C. H. Chalmers, to be demonstrator in agricultural botany.

OXFORD.—A natural science scholarship, of the annual value of 80*l.*, plus 20*l.* laboratory fees, is offered by Keble College, the examination for which will be held on March 11. The subjects will be chemistry or biology, with elementary physics, and for biologists elementary chemistry as well. Applications are to be sent to Dr. Hatchett Jackson at the college. Dr. Jackson will also furnish additional information concerning the scholarship.

THE scheme for fellowships in chemical science in memory of the late Sir William Ramsay has now come to full fruition. At the present time sixteen fellowships for chemical science are being held in the Universities or Colleges of the United Kingdom. The awards for the present session are as follows, the University or College which has been selected by the fellow for his research appearing after the name in each case:—British: Dr. Samuel Coffey (University College, London); Dr. R. W. Lunt (University College, London); and Dr. A. F. Titley (Oxford); Glasgow: Mr. J. A. Mair (Glasgow) and Mr. T. S. Stevens (Glasgow); Canadian: Dr. E. H. Boomer (Cambridge); Danish: Mr. K. Höjendahl (Liverpool); Dutch: Dr. C. F. van Duin (St. Andrews) and Dr. J. Kalff (Liverpool); French: Dr. H. Weiss (Royal Institution, London); Italian: Dr. A. Nasini (Cambridge); Japanese: Dr. N. Kameyama (University College, London); Norwegian: Mr. Gunnar Weidemann (Cambridge); Spanish: Dr. Miguel Crespi (University College, London); Swedish: Mr. A. W. Bernton (Oxford) and Dr. J. Lublin (Cambridge). The total value of the annual amount of the fellowships that is awarded is 5007*l.*, of which 3500*l.* is provided by grants from Dominion and foreign sources.

THE University of Calcutta's "Campaign in connection with Unemployment and the Poverty Problem" is the subject of articles in the *Modern Review* and *Calcutta Review* for December by Capt. J. W. Petavel, who has for some years held the University of Calcutta lectureship in "Poverty Problem Study." His scheme for establishing "educational colonies," more or less self-supporting, where pupils would combine study with vocational training and productive work in workshops and on farms, has won wide acceptance in academic and business circles in Calcutta, but he has not yet obtained the funds necessary for putting it into operation on a scale large enough to afford a fair test of its practicability. In the meanwhile similar ideals have been successfully applied in the Philippine Islands in the Central Luzon Agricultural School. Here the student body is divided into two groups. During the morning one group of boys attends academical classes, while the other group conducts the affairs of the self-governing colony into which the school has developed; in the afternoon the first group in their turn become rice-farmers, vegetable gardeners, housebuilders, blacksmiths, auto-repairers, store-clerks, and bankers. The pupils are paid for their work on the basis of the market value of the products, and many of them thus pay their school expenses. The support from Government funds is less than half the total cost of operation, and it is hoped the institution may become self-supporting. In Fiji and Java projects are on foot for establishing similar schools.

Societies and Academies.

LONDON.

Royal Society, January 24.—H. G. **Cannon**: On the development of an estherid crustacean. The ventral mesoderm of the estherid larva develops a transient segmentation that becomes obliterated by growth. Later, the more dorsal mesoderm develops a series of seven pairs of cœlomic pouches. From the walls of these pouches are developed the dorsal longitudinal extensor muscles, and, in addition, from the first four, the muscular heart-tube. After these have been formed the cavities diminish in size. The space so formed between them and the ectoderm becomes the pericardial cavity. The lower edges of the sacs break connexion with the more ventral mesoderm, except in the maxillary segment, and grow downwards to form lateral portions of pericardial floor. The collapsed remains of the sacs are finally represented by pericardial floor and epithelial covering to the muscular heart-tube. The sacs do not in any way open into the general body-cavity. The genital rudiment is represented in the earliest larva by a paired mass of cells between mesoderm and endoderm. Later, it becomes included in the cœlomic sac of the first trunk segment and grows backwards on each side as a rod, at first solid, of cells in the pericardial floor. —C. **Shearer**: The oxygen consumption rate of parts of the chick embryo and fragments of the earthworm. For equal quantities of tissue under similar physical conditions, the head tissue of the embryo consumed two to eight times more oxygen, measured by the differential manometer, than the corresponding trunk and tail portion of the embryo taken together. The oxygen consumption for a given quantity of tissue is highest in the fourth-day stage, the earliest investigated, and lowest in the tenth-day stage, the latest examined. A measurable quantity of oxygen is taken up by acetone powders, prepared by fixing head and tail portions of a large number of chick embryos in acetone for a week or more, and then thoroughly drying the fixed tissue and reducing it to a fine powder. Again the head portion took up most oxygen. Similar experiments were carried out on the earth-worm, using the Haldane manometer. About 3 cm. of head and tail portion of an almost fully grown starved earth-worm was used. The head region consumed again from two to five times more oxygen than the corresponding tail region of the worm. —N. **Annandale**: The evolution of the shell-sculpture in fresh-water snails of the family Viviparidæ. Details are given of the evolution of prominent shell-sculpture in three series of species of Viviparidæ, namely, (1) in those of the genus Tulotoma, from the Pliocene of Eastern Europe and the Levant; (2) in those of the living and tertiary genus Margarya, in Yunnan; and (3) in those of the living and tertiary genus Taia, on the Shan Plateau of Burma. Each series arose independently, and generic differences exist (or existed), not only in the shell, but also in the anatomy of the three genera. As regards species of Taia, the three forms which live in the Inle Lake, in the Southern Shan States, differ not only in their shells, but also in anatomy and in fertility. Each form is confined to a particular habitat, and one (*T. intha*), which inhabits the clear waters of the lake, is not only the most highly and regularly sculptured, but also the most constant in shell-characters and, in spite of the fact that it is extremely abundant, the least fertile. The last character is associated with lack of competition.—B. **Sahni**: *Tmesipteris Vieillardi* Dangeard: an erect terrestrial species from New Caledonia.—P. A. **Buxton**: Heat, moisture, and animal life in deserts. The surface temperature of Palestine at midday in summer is 55°-62° C. Insects exposed on the hot desert surface are less hot than might be supposed, *e.g.* a grasshopper's internal temperature was 40° C. and the surface on which it crouched 44° C., though insect and surface were alike in colour. A dead insect is hotter than a live one, and it appears that the cooling of the live insect is due to water lost in respiration. About eight insects can endure the Palestine summer sun at midday on bare ground; one of these is black. Fragments of dead annual plants, collected even in the middle of summer, contain 50-60 per cent. of water. Moreover, if these fragments are dried to constant weight and then exposed for periods of 24 hours in atmospheres of increasing relative humidity, they gain very little water until they reach the 70 per cent. humidity; from then onwards the gain is increasingly rapid. If, therefore, the dried fragments of annuals are exposed to a relative humidity of more than 70 per cent. at night (as constantly happens in nearly all deserts) they become actively hygroscopic and provide an unsuspected supply of water to all the desert animals in summer.—A. W. **Bellamy** and C. M. **Child**: Susceptibility in amphibian development.

Geological Society, January 9.—Prof. A. C. Seward, president, in the chair.—S. H. **Reynolds** and E. **Greenly**: The geological structure of the Clevedon-Portishead area (Somerset). The area described is a prominent ridge some 4 miles long and extending between the small towns of Clevedon and Portishead. It is composed of Carboniferous Limestone alone, or of Carboniferous Limestone and Old Red Sandstone. The main part of this ridge consists of Old Red Sandstone overlain by Carboniferous Limestone dipping south-eastwards. The folding along the dominant north-east and south-west axis was accompanied by overthrusting from the south-east. At Portishead the transverse disturbance seems to take the form of a northward thrusting of the main body of the ridge over the east-and-west striking rocks of the Eastwood Ridge. At the Clevedon end the transverse disturbance has also the form of a northward overthrust; but here one of the major thrust-planes of the north-east and south-west series appears to be involved in the disturbance, and doubled back on itself at the Hill Road Crag, Clevedon.—F. S. **Wallis**: The Avonian of the Tytherington-Tortworth-Wickwar Ridge (Gloucestershire). Vaughan's system of zonal nomenclature is used, and the area described is the northern portion of the horseshoe-shaped ridge of Avonian rocks which partly surrounds the synclinal basin of the Bristol Coalfield. All zones, with the exception of the Dibunophyllum Zone, were recognised. There is great expansion of the "Sub-Oolite" bed as compared with that exhibited in the type-section of the Avon. The incoming of "Millstone Grit" conditions is early.—Miss A. E. **Bamber**: The Avonian of the Western Mendips, from the Cheddar-Valley Railway to the sea, west of Bream Down. Comparison is made between the Avonian of the Western Mendips, and (*a*) the Avon section and (*b*) the Burrington Combe section. The outcrops of the Carboniferous Limestone zones have been mapped, using the zonal notation of the late Dr. Vaughan. The lithological sequence in the Western Mendips is essentially similar to that of the Avon section.

PARIS.

Academy of Sciences, January 7.—M. Guillaume Bigourdan in the chair.—Paul **Appell**: The polynomials connected with Eulerian integrals.—J. **Costantin**: Remarks on the relations between trees and subterranean fungi. Trees, especially oak trees, are usually found in association with truffles.

Laboratory experiments with *Tuber brumale* show that the tree is not necessary for the formation and ripening of the ascospores.—Marin **Molliard**: The behaviour of *Sterigmatocystis nigra* in the presence of various sugars in media containing only small proportions of mineral matter. Experiments on the oxidation of sugars to gluconic acid by the mould.—Ch. **Gravier**: The evolution of a parasitic Crustacean, *Flabellicola neapolitana*.—F. **Mesnil** and M. **Caullery**: The complexity of the evolutive cycle of the polychætal annelids.—M. de **Chardonnet**: The storage of volatile liquids in industry. Collodion prepared for making artificial silk improves on storage: details are given of the mechanical arrangements for storing and removing the liquid without loss.—Sir Almroth E. **Wright**: New methods for the study of infection and the treatment of tuberculosis. An account of the results of applying the methods of hæmoculture in thin films and in capillary tubes to tuberculous infection. The same method had been applied earlier to the study of the staphylococcus and streptococcus infections.—P. **Sergesco**: Extension to symmetrisable nuclei of the theorems of M. Weyl.—J. **Priwaloff**: Sequences of analytical functions.—A. **Zygmund**: Limited Fourier's series.—E. **Cartan**: Differential forms in geometry.—Paul **Alexandroff**: Aggregates of the first-class and abstract space.—M. **Lavrentieff**: Homeomorph aggregates.—Vasilesco **Karpen**: The use of horizontal fluctuations of the wind by hovering birds. Reply to a criticism of M. Nordmann.—E. **Huguenard**, A. **Magnan**, and A. **Planiol**: The aerodynamical study of the wings of birds and of flexible planes.—Ernest **Esclangon**: The Einstein deviation of light rays by the sun: a discussion of the observations made by Campbell and Trumpler during the solar eclipse of 1922. The conclusion drawn is that the observations neither confirm nor oppose the Einstein law of deviation. There are indications of deviations in the neighbourhood of the sun, but neither the law of deviation nor the exact magnitude at the sun's border can be fixed. The effect actually observed may result from the superposition of several distinct phenomena: refraction in the sun's atmosphere, Courvoisier's cosmic refraction, and the Einstein deviation.—E. **Friedel** and F. **Wolfers**: The variations of the wave-length of the X-rays by diffusion and Bragg's law. A discussion of some recent results of A. H. Compton.—F. **Croze**: The heights in the bright line spectrum of resonance lines and ultimate lines in elements possessing several systems of series.—M. **Ferrières**: The ultra-violet absorption spectrum of gaseous ammonia. The absorption spectrum of ammonia is composed of a series of triplets arranged according to a regular law: excepting the first, all have average frequencies the successive differences of which are about 900.—René **Dubrisay** and Pierre **Picard**: The surface tension exerted at the surface of separation of water and an organic liquid in the presence of the fatty acids and of alkalis. Solutions of fatty acids in benzene of varying concentration were prepared, and the changes in surface tension measured by the sizes of the drops of water, N/1250, and N/2500 soda solutions.—E. **Demoussy**: The displacement of acids by diffusion. In the dialysis of a solution containing barium chloride and formic acid, it has been proved that more chlorine than barium passes through the membrane. It is now shown that the phenomenon is probably simple diffusion, since similar results can be obtained in the absence of a membrane.—Paul **Pascal**: The "insoluble" alkaline metaphosphates. Two methods of preparing insoluble sodium metaphosphates are described, one by heating microcosmic salt to 355° C., the other by heating sodium methylphosphate or ethyl phosphate to a dull red heat. The properties of the two metaphosphates thus obtained are compared: they are not the same.—V. **Auger** and Mlle. L. **Odinot**: The reduction of arsenic acid by sulphurous acid in the presence of vanadic acid. The conclusion of Trautmann that in the presence of vanadic acid arsenic acid is not reduced by sulphur dioxide is erroneous: following Gooch's method of reduction, or working cold in the presence of potassium iodide as a catalyst, both arsenic and vanadium are completely reduced.—A. **Wahl** and W. **Hansen**: The transformation and constitution of disulphisatyde.—Marcel **Sommelet**: The preparation of methylamine. A modification of the method of Brochet and Cambier using ammonium chloride and formaldehyde. The final purification of the amine from ammonia and trimethyl-trimethyline-triamine is effected by condensation with benzaldehyde to the imine $C_6H_5 . CH : N . CH_3$, separation by distillation, and hydrolysis of the imine by hydrochloric acid.—F. **Kerforne**: The Oligocene of the Armorican massif.—J. **Rempp**: The diurnal variation of the wind at Strasbourg and the theory of the Fohn.—Stanislas **Golinski**: Researches on the variation of chemical composition in tomatoes grafted on potatoes and on *Lycium barbarum*. The variation in the proportions of acid, reducing sugars, and saccharose were determined. A. **Maige**: Formation of starch and evolution of the plastids in the embryo of the bean.—G. **Nicolas**: Mycorhizic formations in *Lunularia vulgaris*.—E. **Chemin**: The germination of the seeds of *Lathræa clandestina*.—Auguste **Tournay** and Edouard **Krebs**: The effect of mechanical action bearing on the sympathetic nerve system compared with the effects of electrical stimulation.—H. **Simonnet**: Are the requirements the same for the two sexes during growth? From experiments on rats it was shown that under identical conditions as regards food, males and females showed differences in development, in the onset of xerophthalomia, and in time of survival. M. **Tiffenau** and C. **Torres**: The hypnotic properties of hydrobenzoin and its alkyl homologues (symmetrical diarylglycols). Relations between the physiological activity and the molecular weight. The hypnotic power for fish of the alkylhydrobenzoins increases regularly with the number of carbon atoms, that is, with the molecular weight, and inversely with the solubility in water.—L. **Léger**: The geographical distribution of *Branchiura Sowerbyi* and its rôle in pisciculture.—J. **Feytaud**: The termite of Saintonge. There are two distinct species of Reticulitermes in France, one certainly indigenous, the other probably exotic.—G. **Petit**: Remarks on the lobation of the kidney in the manatee.—A. **Paillot**: Two parasitic bacteria of the larvæ of *Neurotoma nemoralis*.—R. **Courrier**: Remarks on the fertilising membrane of the egg of the sea urchin (*Paracentrotus lividus*).—E. **Fernbach** and G. **Rullier**: Application of the Sörenson reaction to the study of the toxic power of tuberculin. Tuberculin, made neutral or alkaline, retains its toxic power unchanged, and this is also the case after addition of formaldehyde alone. But, if after suppression of the amine function by formaldehyde, the carboxyl group is neutralised with soda, the toxicity disappears.—M. **Lemoigne**: The production of β-oxybutyric acid by the action of micro-organisms.—C. **Levaditi**, S. **Nicolau**, and Mlle. R. **Schoen**: Microsporidiosis of the rabbit: its relations with hydrophobia. In previous communications the authors have given a detailed account of *Encephalitozoon cuniculi*, the first microsporidium proved pathogenic to animals. It is now shown that this disease is transmitted by the digestive tract, and that mice are susceptible to it. The hypothesis is put forward

that hydrophobia may be due to a microsporidium.—Auguste Lumière: Concerning the irregularities of the lactic fermentation in the presence of certain antiseptics. Reply to criticisms of M. Richet.—A. Boquet: The rôle of traumatisms in anthrax infection of the guinea-pig by the alimentary canal.

Official Publications Received.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. New Series, No. 18, January. Edited by W. F. Spear. Pp. 208. (London: Great George Street.)

Appendix No. 2 to the Annual Report of the Chief of the Bureau of Navigation, 1923: Annual Report of the Naval Observatory for the Fiscal Year 1923. Pp. 25. (Washington: Government Printing Office.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 240: Precise Leveling in Georgia. By Henry G. Avers. (Special Publication No. 95.) Pp. ii+107. (Washington: Government Printing Office.) 15 cents.

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (The Fernley Observatory of the Corporation of Southport). Annual Report, and Results of Meteorological Observations, for the Year 1922; with an Appendix containing Hourly Averages, from 20 Years' Observations, of the Duration, Amount, and Intensity of Rainfall. By Joseph Baxendell. Pp. 36. (Southport: Fernley Observatory; London: Meteorological Office.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1922-23. Pp. iv + 45. Barbados.) 6d.

Proceedings of the Edinburgh Mathematical Society. Vol. 41. (Session 1922-23.) Edited by Dr. Archibald Milne and Dr. George D. C. Stokes. Pp. viii+160. (London: G. Bell and Sons, Ltd.) 10s. net.

Year-Book of the Royal Society of London, 1924. (No. 28.) Pp. iii+213. (London: Harrison and Sons, Ltd.) 7s. 6d.

National Research Council. Organization and Members, 1923-1924. Pp. 56. (Washington, D.C.: National Academy of Sciences.)

Reprint and Circular Series of the National Research Council. No. 49: Statement of Activities of the National Research Council for the Year, July 1, 1922-June 30, 1923. By Vernon Kellogg. Pp. 16. (Washington, D.C.: National Academy of Sciences.) 25 cents.

Bergens Museum. Aarsberetning, 1922-1923. Pp. 77. (Bergen: A/S John Griegs boktrykkeri og N. Nilssen & Søn.)

Bergens Museums Aarbok 1921-1922. 2 Hefte. Naturwidenskabelig række, Nr. 7: Hardangeromraadets Hieraciumflora. Av S. O. F. Omang. Pp. 216. (Bergen: A/S John Griegs boktrykkeri og N. Nilssen & Søn.)

The National University of Ireland. Calendar for the Year 1923. Pp. viii+323+359+102. (Dublin.)

Diary of Societies.

SATURDAY, FEBRUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Wallace: Influence upon Composition of Improvements in Musical Instruments.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—H. Main: A Pilgrimage to Provence.

MONDAY, FEBRUARY 4.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. K. M. Walker: The Internal Secretion of the Testis.

SOCIETY OF ENGINEERS, INC. (at Geological Society), at 5.30.—G. A. Becks: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—F. W. Crawter and others: Discussion on Storage Battery Troubles.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—K. J. Spalding: The Presuppositions of Philosophy.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. K. Rideal: Colloid Chemistry (Cantor Lectures (3)).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Engineers' Club, Coventry Street), at 8.—Prof. J. W. Hinchley: The Manufacture of Potash and other Salts from Leucite.

INSTITUTION OF RUBBER INDUSTRY (at Engineers' Club, Coventry Street), at 8.—F. Kaye: The Use of Rubber Latex in the Manufacture of Boards, Leather, and Linoleum Substitutes, and as to the Vulcanisation of these Products.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presidential Address to Students and Presentation of Prizes.

TUESDAY, FEBRUARY 5.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—F. W. Walker: The Commercial Future of the Backward Races, with special reference to Papua.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. A. Dendy: What is Heredity? (2).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Secretary: Report on the Additions to the Society's Menagerie during the Months of November and December 1923.—Dr. N. S. Lucas: Report on the Deaths which have occurred in the Society's Menagerie during 1923.—C. Tate Regan: Reversible Evolution with Examples from Fishes.—M. A. Smith: New Tree-Frogs from Indo-China and the Malay Peninsula.—R. R. Mole: The Trinidad Snakes.—Mary L. Hett: (1) The Family Linguatulidæ; (2) Zoological Results of the Third Tanganyika Expedition conducted by Dr. W. A. Cunnington, 1904-1905: Report on the Linguatulidæ.

INSTITUTION OF CIVIL ENGINEERS, at 6.—T. R. Nolan: Slips and Washouts on the Hill Section of the Assam-Bengal Railway.—R. D. Walker: Underdrainage and its Application to Railway Work.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. L. Coburn: Address to Pictorial Group.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—W. E. Armstrong: Rossel Island Money.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—Prof. H. S. Gasser: The Recording of Action Currents in Nerve with special reference to the Use of the Cathode Ray Oscillograph.

WEDNESDAY, FEBRUARY 6.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. C. M. Page: The Surgical Treatment of Osteo-arthritis.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. O. T. Jones: The Upper Towy Drainage System.

NEWCOMEN SOCIETY (at 17 Fleet Street), at 5.30.—Short Papers.

INSTITUTE OF PHYSICS (at Chemical Society), at 5.30.—Prof. C. H. Desch: The Physicist in Metallurgy.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—F. W. S. Hawtayne: The Bristol Waterworks—Past and Present.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—E. B. Moullin: Atmospherics and their Effect on Wireless Receivers.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.—R. Paulson: Symbiosis or Parasitism?

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (Annual General Meeting) (at Chemical Society), at 8.—Presidential Address.—C. Ainsworth Mitchell: Osmium Tetroxide as a Reagent for the Estimation of Tannins and their Derivatives.—G. D. Elsdon: The Composition and Examination of Beef and Malt Wine.—S. A. de Lacy: Demonstration of an Apparatus for Fat Extraction and Solvent Recovery.

ROYAL SOCIETY OF ARTS, at 8.—I. Tokugawa: The Earthquake and the Work of Reconstruction in Japan.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—Dr. J. W. Pickering and J. A. Hewitt: Further Experiments on the Action of "Peptone" on Blood, with Notes on the Significance of Surface Phenomena in the Problems of Anaphylaxis and Susceptibility.—L. B. Winter and W. Smith: Studies on Carbohydrate Metabolism. I. Variations in the Nature of the Blood Sugar.—E. C. Grey: The Latent Fermenting Powers of Bacteria. Parts I., II., and III.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: The Crystalline Structure of Organic Substances (1).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Squadron Leader Maycock: Airmanship at Sea.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Grace Owen: The Present Prospect of the Nursery School.

CHEMICAL SOCIETY, at 8.—N. V. Sidgwick and R. K. Callow: (1) The Solubility of the Aminophenols; (2) Abnormal Benzene Derivatives.

FRIDAY, FEBRUARY 8.

ROYAL ASTRONOMICAL SOCIETY (Anniversary Meeting), at 5.

PHYSICAL SOCIETY OF LONDON (Annual General Meeting) (at Imperial College of Science and Technology), at 5.—E. G. Richardson: Æolian Tones.—J. E. Calthrop: The Effect of Torsion on the Thermal and Electrical Conductivities of Metals.—C. W. Hawksley: Demonstration of a Microscope with Special Eyepiece for the Observation of Interference Fringes.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. W. H. Ogilvie: The Infection of the Upper Alimentary Tract.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—R. W. Wilson: Repair and Upkeep of Pneumatic Tools.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Lantern Lecture.

ROYAL INSTIIUTION OF GREAT BRITAIN, at 9.—Sir Arthur Evans: Recent Lights on the Minoan Art of Crete.

PUBLIC LECTURES.

SATURDAY, FEBRUARY 2.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—C. N. Bromehead: A Geologist's History of London.

MONDAY, FEBRUARY 4.

UNIVERSITY COLLEGE, at 5.30.—Prof. Morton Prince: Psychology. (Succeeding Lectures on February 6 and 7.)

TUESDAY, FEBRUARY 5.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Transition to the Relativist Conception of Nature. (Succeeding Lectures on February 12, 19, 26.)

FRIDAY, FEBRUARY 8.

UNIVERSITY COLLEGE, at 5.15.—Dr. Bernard Hart: Psychology and Medicine.—At 5.30.—Dr. D. Heron: Business Forecasting.

SATURDAY, FEBRUARY 9.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—E. Lovett: The Origin of Children's Toys.